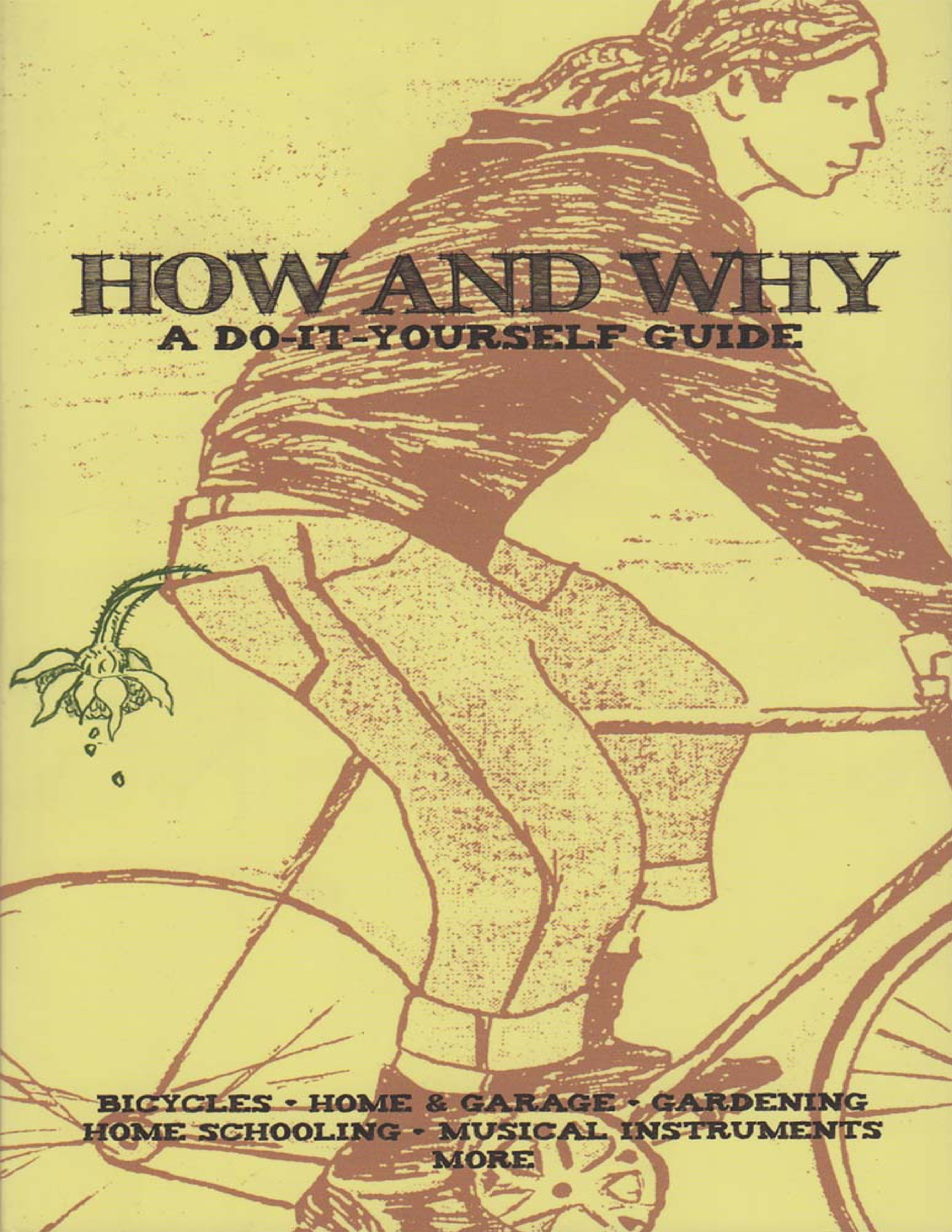


HOW AND WHY

A DO-IT-YOURSELF GUIDE

BICYCLES • HOME & GARAGE • GARDENING
HOME SCHOOLING • MUSICAL INSTRUMENTS
MORE

HOW AND WHY
A DO-IT-YOURSELF GUIDE

BY MATTE RESIST

PHOTOGRAPHS BY MATTE RESIST,
RACHAEL ANN, ESTHER B. & JED

ISBN 978-1-934620-04-5 | THIS IS MICROCOSM #76071

FIRST EDITION OF 5,000 COPIES - FEBRUARY 15, 2011

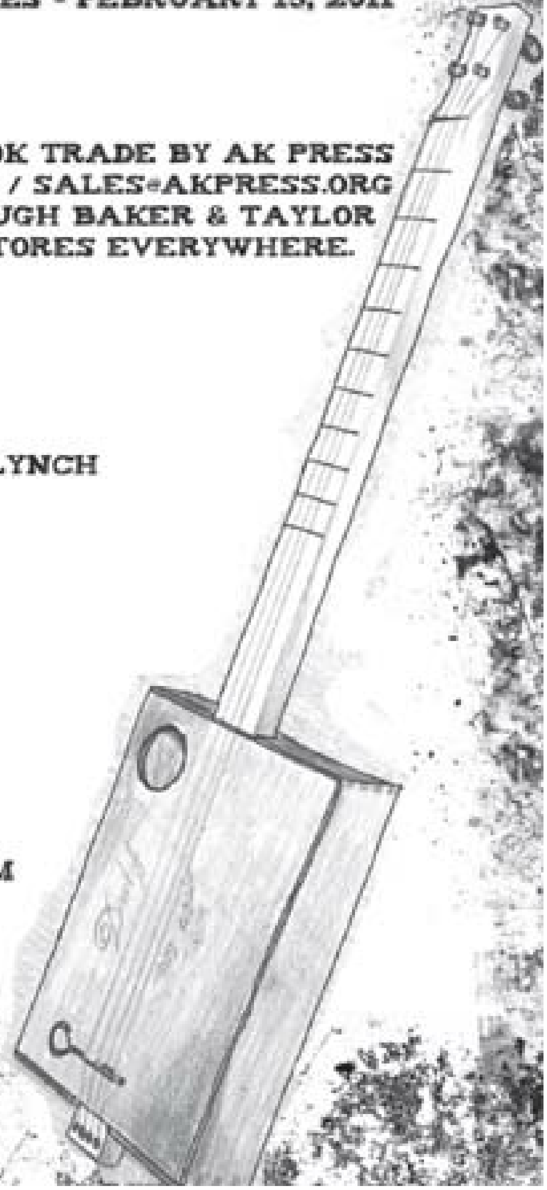
DISTRIBUTED IN THE BOOK TRADE BY AK PRESS
(510) 208-1700 / SALES@AKPRESS.ORG
AVAILABLE THROUGH BAKER & TAYLOR
INGRAM, AND FINER BOOKSTORES EVERYWHERE.

COVER DESIGN BY E CHRIS LYNCH
BOOK DESIGN BY JOE BIEL
FONTS BY IAN LYNAM

MICROCOSM MAILORDER
222 S ROGERS ST.
BLOOMINGTON, IN 47404

MICROCOSM HQ STORE
636 SE 11TH AVE
PORTLAND, OR 97214

MICROCOSMPUBLISHING.COM



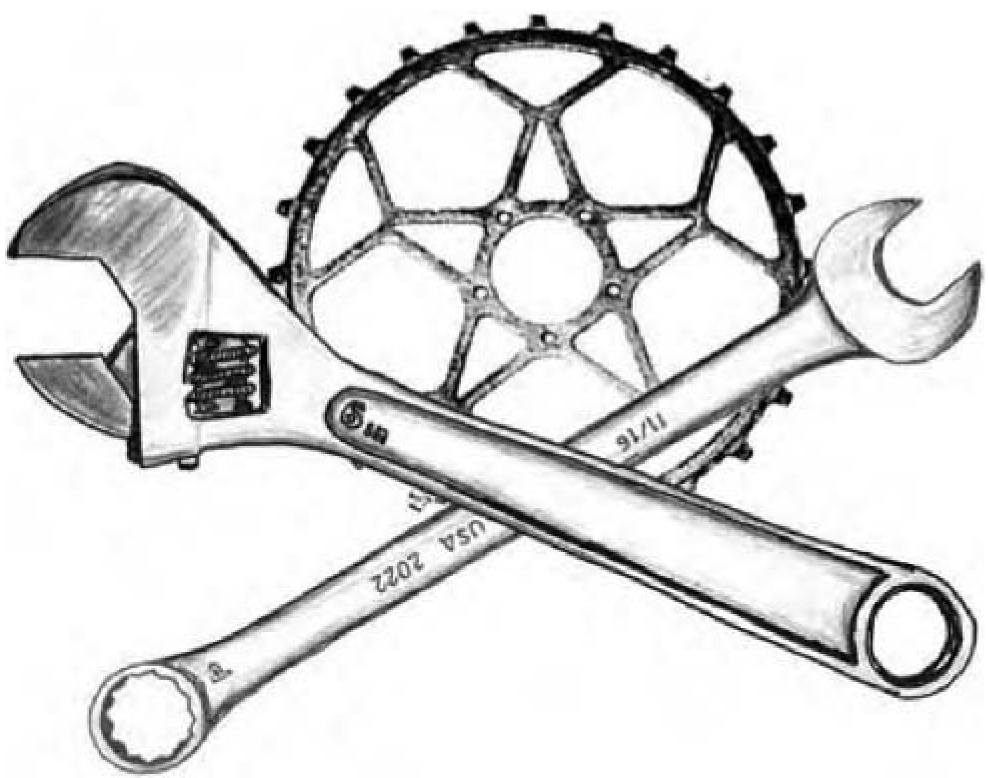
It's sad, but disclaimers have to be made. Without them I put myself and Microcosm at risk if people attempt to follow my example and end up harming themselves. The book is about doing it yourself, but I have to tell you that this book is full of stories about what has worked for me. The content of this book is not guaranteed to be factual, scientifically valid, healthy or safe. The reader assumes full responsibility for action taken as a result of any article in this book. Neither Matte Resist or Microcosm Publishing are responsible for the contents therein, the actions of readers in response to the articles contained in this book, or any consequences that may occur as a result of these actions.

I can be contacted at:

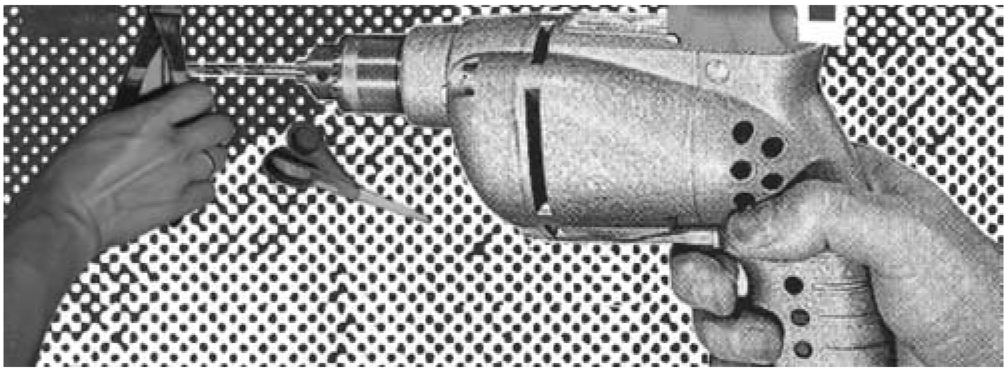
Bicycle Lane Industries
P.O. Box 582345
Minneapolis, MN 55458
www.bicyclelaneindustries.com
matte@bicyclelaneindustries.com

THANX

When I first made zines, we put a "thanks" section in every issue. Many of these were pretty silly, like thanks to Jell-O, which we consumed in mass quantities. It now feels weird to have a real "thanks" section, but some people deserve credit for helping me finish this book. First off, thanks to my wife, Rachel, and my kids, Jed and Esther, for putting up with what seemed like a never-ending parade of projects for the last year and a half and which, at times, superseded projects they would have preferred to do instead. Thanks to my Mom, Dad, and Rachael for helping with editing. Thanks to Esther, Jed, and Rachael for taking photographs. If I had drawn everything, it would have taken me half a decade to finish this book. Thanks to those who were willing to share their knowledge. If certain folks hadn't been there to answer questions when I was getting stuck, some of these projects might have never happened. And thanks again to my Dad, who taught me to do it myself when I was a kid.



INTRODUCTION



I dream of a better world where every move isn't ordained by government, big business, and money. To me, DIY culture is about grabbing a little piece of that dream. Every little thing I do myself is a step towards doing the big things myself.

Every bike ride puts me a little closer to throwing off the shackles of the automotive and petroleum industries. Every tomato I eat out of my own garden plows the way to a future where all food is grown with respect for creation and for the person who will eventually eat that food. Everything I can wrest from the hands of business and do myself distances me from a system in which the majority are exploited to benefit the few.

This book won't thrust you into self-sufficiency. You probably won't break free of the stranglehold that the government has on your freedoms. But perhaps it'll inspire you to take some of that back. From the time I became involved in DIY culture, my main goal has been to inspire.

I hope to inspire people to dream of a better world, and that those dreams will take root and sprout into actions. I hope that you'll be inspired to climb out of

that cage, and onto a bicycle or your own two feet and enjoy the warmth of the sun, the chill of night air, and the smell of things that grow. I hope that by teaching you what I know, you will teach others.

I'm not interested in having people make perfect imitations of my projects; I'm interested in inspiring people to try new things. I know this is tough, because I struggle with the same thing. When I get started on a project this voice in my head tries to tell me that I don't know what I'm doing, don't have any experience or skill, and that there's no way I'm going to finish it.

Yet here I am with an entire book full of projects that I've completed. So when you get that same voice in your head, don't believe that nonsense. A guy who was working on my car once told me that you might as well jump in and give it a try, because the worst thing that's going to happen is that it's not going to work. What have you got to lose?

If you're buying all your food at the grocery store, what have you got to lose by planting a garden? If you don't get any veggies, you buy your food at the store like you've always done.

So if you succeed it's all gain. You don't have to bring your car to the mechanic, you can eat fresh tomatoes out of your garden, you can transport yourself with the power of your two strong legs!

This book didn't turn out quite like I expected. Some of my projects took longer than I thought, and sometimes I ran into unexpected obstacles, like seasonal depression, and troubles with the local government. Other projects are nearing completion to be printed in my next book or zine.

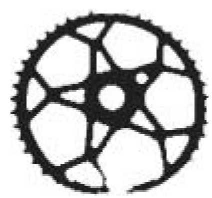
This book has a heavy lean toward a couple of my favorite pastimes, building and riding bicycles, and gardening. There's also a lot of stuff about instrument building because it's something that I found that I really enjoy, and thought that you might too.

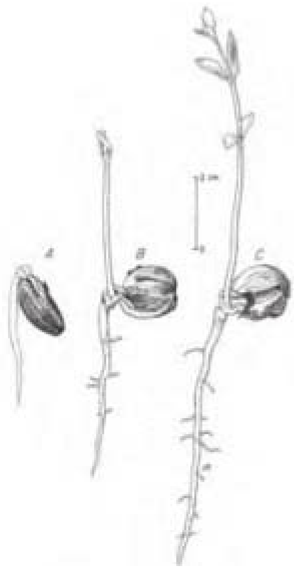
I hope that this book inspires you to try something new, and to pass along that knowledge to someone else. I'd love to see your own DIY zines. If you do one, please send it my way, I love that stuff! Good luck with all your future projects!

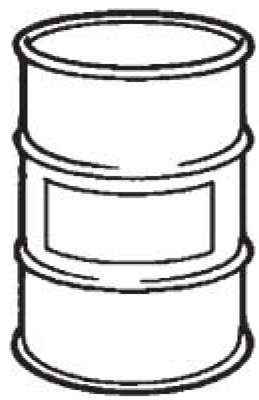
- Matte Resist

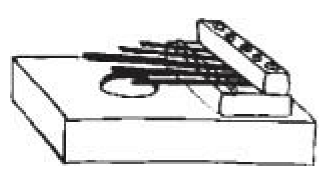
CONTENTS

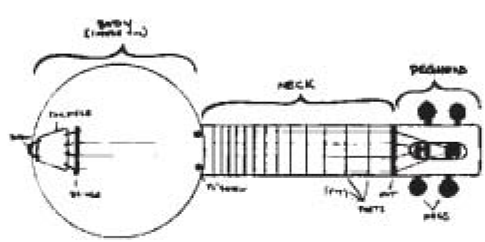
Bike tube bungee cords
Soda pop can solar panel
Pallet bed loft
Dumpster shopping





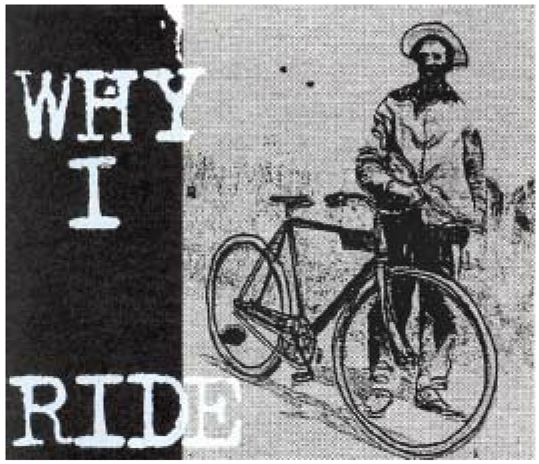





NECK

BICYCLES

WHY I RIDE



There are so many reasons for riding a bike! Most people who pick up this kind of book probably already ride for transportation. But we all need reminders of why we do what we do, and that's what this section is about!

THE CASE AGAINST CARS

In many places, bicycling is the best alternative to driving a car.

There are numerous problems with relying on automobiles and pollution is only one of them. But it's the one many people are most concerned with and with good cause. Gasoline and diesel engines emit almost half the carbon monoxide, hydrocarbons, and nitrogen oxides that result from all fossil fuel combustion worldwide.

In the U.S. the invention of the catalytic converter in the 1970s lowered the level of pollutants, but our car fleet has grown so fast since that it put us right back where we were. Controls on auto emissions are virtually non-existent in several other nations where the car fleet is growing even faster.

China, for example, used to be a country of bicycles. In 1996, one in 260 people owned a car. Most people in China don't have the money for a car, but the growing number that do are demanding them. Pollution levels from all

these new cars are set to rise 30%, sending smog drifting across to California and damaging Chinese food production.

Another thing to consider is the pollution from autos doesn't only come from driving them. Over six pounds of toxic chemicals are released into the environment with every car produced. By the time a car leaves the factory it has generated 29 tons of solid waste, 1,207 million cubic yards of air emissions, and used 12,000 gallons of formerly clean water.

When it's time to dispose of a car, there's more pollution. After being stripped of good parts, it's shredded so the metal can be recycled. About 20% of the shredded material, along with toxic heavy metal residues it contains, ends up in landfills.

Global warming aside, the health problems caused by pollution are well documented. Tests show that exposure to car exhaust or smog can be worse than smoking. Asthma and cancer rates are much higher along busy roads.

> Asthma went up 50% between 1980 and 1989, and asthma deaths tripled between 1980 and 2000. Studies have shown cancer rates as much as 9 times higher along busy roads than along quieter streets.
>
> \- *Divorce Your Car*

Then there is noise pollution. Noise incites our fight or flight response, which increases stress hormone levels, blood pressure, heart rate, and muscle tension. Besides being stressful, living near a loud, busy road damages hearing, affects sleep, hinders learning in children, hurts concentration, and hampers memory. It also increases depression, irritability, and argumentative behavior. Noise is driving us crazy!

Noise incites our fight or flight response because it's subconsciously perceived as a threat. The symptoms mirror those of stress: increased stress hormone levels, blood pressure, heart rate, and muscle tension. Some studies link heart

disease, ulcers and premature death to noise pollution. The World Health Organization (WHO) suggests that daytime noise levels not exceed 65 decibels(dB), but 127 million people live in noise pollution above 65(dB). 10 million people endure 75(dB) or more which is at least twice as loud as the 65(dB) recommended by WHO and the level at which hearing loss begins to occur.

Then there's oil. About 25% of the used motor oil in North America is poured down the drain, on the ground, or put in the trash. Only one gallon of oil can contaminate one million gallons of water. 75% of "properly disposed" oil is burned in heaters and engines, releasing heavy metals into the air.

We can't blame the car for all of the 20 million gallons of oil that are spilled every year. Leaks happen at every stage of oil production and distribution: drilling, storage, and transportation. Not all pollution is even accidental—it's estimated that 75% of ocean oil pollution is intentional.

> Oil tankers routinely discharge oily waste water from holding and ballast tanks.
>
> \- *Divorce Your Car*

THE END OF OIL?

The oil supply probably won't hold out much longer. U.S. oil production has been falling for almost 40 years—we hit our peak in 1970 and have been using more than we can produce since 1946. Since 1998, over half of our oil is imported from foreign countries.

With competition from countries like China, the world doesn't seem to have

enough oil to go around. There is talk about drilling for oil in the arctic, but that would produce only 15 billion barrels, or two years worth at our current consumption rate.

The world isn't doing much better. We've been using 24 billion barrels of oil a year since 1995 but have only found 9.6 billion barrels each of those years.

During the 1973 oil embargo, world production dropped by only 9%, but it caused dramatic change. City planners started looking into mass transit. Auto makers were retooling to produce smaller cars. Suburban real estate prices dropped. We seemed well on our way to reducing our dependence on oil. Then OPEC ended the embargo and consumption jumped right back up to previous levels.

Although oil companies will deny it, all signs point to the world reaching peak oil in the not too distant future. When this happens oil production will start to drop, the amount of available oil will drop increasingly fast, and never recover. Demand for oil only keeps going up, so the price will skyrocket and the depression will be severe, much worse than the little dip in the 70's. Time for a smooth transition is running out.

This is called Hubbert's Curve or Hubbert's Peak theory. It is modeled on the production curve of individual oil wells. With this theory he was able to accurately predict peak oil for the United States. Using his theory others have predicted world peak oil between 2010 and 2030.

We commonly hear that cleaner-burning, "environmentally friendly" fuels are the solution to both pollution and dependence on foreign oil. But these only stop producing one pollutant in exchange for another. Methanol contributes to ozone, while coal-based fuels produce twice as much carbon dioxide.

The use of crops like corn to produce alternative fuels poses its own

problems. We're already harming our soil and making it less productive by the way we grow crops. Already we've seen the price of corn based foods going up because they have to compete with ethanol—and government subsidies for ethanol are making this worse.

The problem is not only energy. It's time, it's space, and it's cost. At least a third of an average city's land is devoted to cars. This includes parking lots, roads, and other infrastructure. Yet roads cannot be built fast enough to accommodate all the cars.

The principle of induced demand has been proven again and again. The more roads are built, the more people drive. If driving was too inconvenient at a certain place or time, a new road is built, people think driving will be easier, and the new road's benefit is short lived.

New roads encourage new development, which puts more autos on the road to get to the new places. We cannot continue to build more roads for the car, because there will never be enough.

One final subject is cost. According to AAA, in 2008 the average car cost $7,096 to own and operate each year, if you put 10,000 miles on your car. This makes the average cost per mile 71 cents. So if you're driving three miles each way to get some cheap fast food, it costs you $4.26 to get there and back. Not so cheap. A quick trip to the hardware store to pick up some 20 cent lag bolts raises their cost to a buck apiece. The point is, owning a car costs you more than gas. You've also got maintenance, tires, insurance, license and registration, depreciation, and finance charges. AAA doesn't even factor in parking, tolls, tickets, etc.

The government has been subsidizing cars since the beginning. An estimated $41 billion a year for road infrastructure is covered by taxpayers, whether or not they drive. And then there are the subsidies given directly to oil companies. Conservative estimates have the government giving $235 billion

to oil, gas, and coal every year!

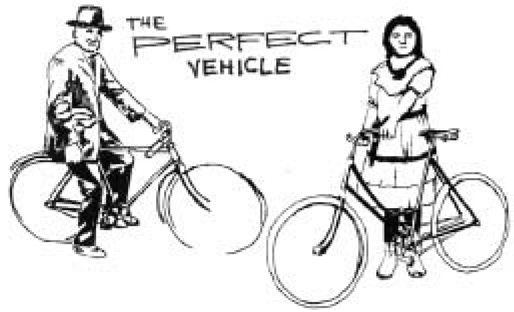
It's hard to think about how much cars cost us because we pay for most of it indirectly. We can talk about crop loss from pollution, at $5 billion a year. You can add over $9 billion in productivity losses from traffic jams alone. We also pay for police to enforce the rules of the road. Consider what your time is worth. The average American spends an hour a day in the car, and even more caring for their cars.

Of course the ultimate price that is paid for automobiles is life. Between 500,000 and 1,000,000 people are killed by cars every year. Every two seconds, someone is injured by an automobile. The deaths aren't limited to people in cars—too often, innocent pedestrians and cyclists are struck by inattentive, aggressive, or distracted motorists.

Start figuring in the lives affected by wars fought for oil and the figure is astounding. Is the car really worth what we pay for it?

We cannot continue to cater to the car! We have to throw out that whole system and come up with a new solution! And that solution is the bicycle.

My hope is that if you're not already using a bicycle as your main source of transportation that the facts above will get you to try it. And once you start, I think you'll want to keep doing it.



THE PERFECT VEHICLE

> All you have to do is make it easier to ride a bike than drive a car… people will take it from there.
>
> - Ellen Fletcher

Bicycling consumes less energy per passenger mile than any other form of transportation. Even walking consumes three times the energy of cycling! A cyclist can ride 3.5 miles on the calories found in an ear of corn, and doesn't need the corn distilled and refined before using it for fuel.

One study showed that 70% more energy is required to produce ethanol than the energy that is in the final product. Best estimates show that it takes one unit of energy to produce 1.24 units of ethanol energy. Cars are the definition of inefficiency. It takes about 415 ears of corn to make one gallon of ethanol. A car that gets 25 miles per gallon on gasoline can expect to get about 15 mpg on ethanol. So those 415 ears of corn will power a car for 15 miles or a cyclist for 1,245 miles. It would take 97% of the area of the U.S. to grow the corn required to power all the nation's cars on ethanol.

WHY BIKES ROCK

Do you remember the first time you rode a two wheeler bike? It's a rite of passage that just about every child goes through.

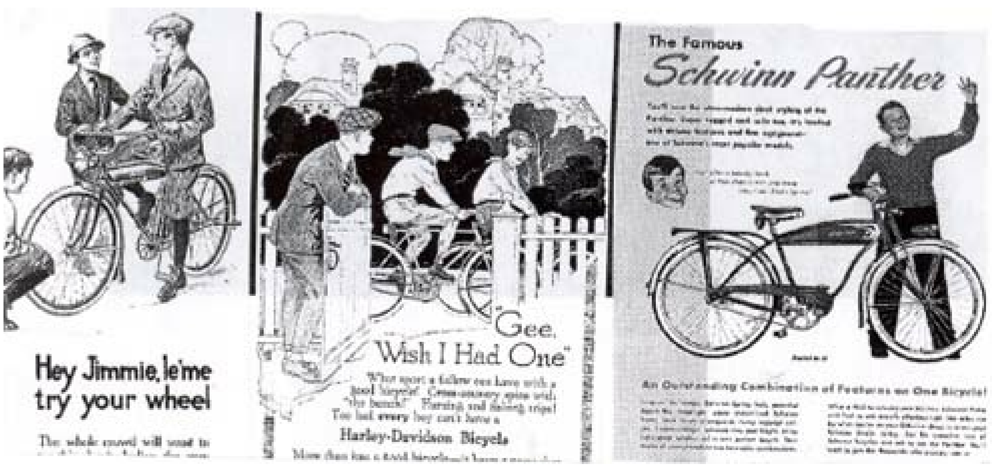
When it was time for me to learn to ride a bike, my dad brought me out into the parking lot. He pushed and I pedaled until I had it down. It took a bit of time and a few falls, but I got it. It was a passport to freedom! Pretty soon I was riding around the block, and then around the neighborhood, and then on secret treks to creeks, bridges, railroad tracks, and dirt paths with jumps. My bike gave me a sense of autonomy. When I was supposed to ride the bus to summer school, I'd convince a friend that we should ride our bikes the few miles instead. Sometimes we'd ride to the creek to catch snakes and turtles and never show up to school at all. It was always about pushing the limits.

When my friends started to get cars, I wanted one too. And let's be honest, when I got one, that felt like freedom too. Now I was able to drive all over the country and because it was a van always have a place for me and a couple of friends to stay.

As I got older, I wanted to drive less and had less money to spend on the car. One day I was walking to the bus stop and I saw an abandoned bicycle

sticking out of a snow bank. After putting some air in the tires, it was good to go so I rode it to work.

Again, it was all about freedom! I could get places faster than walking or waiting for the bus that was always late. And I saved $15/week by not riding the bus!



Riding a bike is cheap. The one I have now cost $200 and is the most expensive bike I've ever owned. In the past I've gotten around just fine riding bikes I've pulled from the garbage or picked out at a thrift store for less than $20.

The biggest expense I have riding a bike is buying a new tube about once a month. So 12 tubes a year at $5 each is $60. I might spend $30 on new tires every year, and $10 on a chain. That puts me at about $100 a year to keep my bike running. Considering that I put at least 3,000 miles a year on it, that adds up to three cents a mile, 4% of what it costs to drive a car!

Bicycling also keeps me healthy. I have a voracious sweet tooth, and riding to and from work easily takes care of the calories in a couple of donuts. A vigorous ride burns over 800 calories in an hour, and a more leisurely hour's riding will burn 500 calories. So I basically eat what I want and maintain my weight.

Plus I feel good when I'm riding. The more I ride, the stronger I get. The hills that used to bother me when we first moved don't faze me anymore. I'm getting my exercise, getting where I'm going, and having fun at the same time. I'm not paying money to go to some gym and pedal a bike that doesn't go anywhere—I'm out there enjoying the scenery, the fresh air, and whatever kind of weather it happens to be.

I like being out in the world. I like feeling the night get cool as the sun goes down. I like to feel the sun on my skin. I love passing a mile of motorists that are sitting there in their little cages, waiting to move. I like leaving my bike ten feet from the front door of a shop while I run in instead of driving around looking for a parking spot. I like being able to chat with another biker when we end up at a stop light together.

I really like riding with friends. You can goof around the whole way, and move through the group chatting with whoever you want. Or if you feel like it you can cruise up ahead of everyone and lead the pack. Writing this makes me want to find a few people to go riding with right now.

It's not only doing "the right thing," it's doing the fun thing. Sure, bikes are safer, cheaper, more environmentally friendly, and healthier than automobiles. They're the perfect machine. And on top of all that, they're fun!

Lastly, bikes are simple to maintain! I hate working on cars: They're confusing, cramped, rusty, smelly, and expensive to try to fix.

Changing a flat tire with numb fingers on a freezing day has its downsides, but for the most part, bike maintenance is enjoyable and relaxing. With a basic set of hand tools and bit of grease you'll be able to fix just about any problem you come across in short order. You can take a bike completely apart and put it back together in an evening. The bike makes me feel self-sufficient—there's seldom anything that I can't figure out for myself!

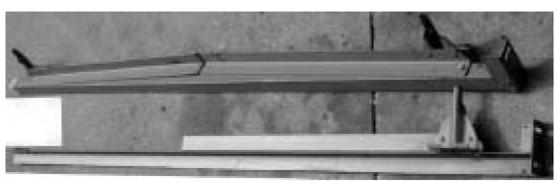
My hope is to help you feel confident about working on your own bike, and give you the feeling of independence that the bicycle did when you were a kid.

BIKE TRAILER

Bicycles lose a lot of practicality if you don't have a way to haul things. Baskets and racks work alright, but you can haul a lot more with a trailer.

I set out to come up with a cheap, efficient bicycle trailer design that anybody can build and that can be easily modified to whatever size you need. Here is what I made.

Supplies:
- bed frame - FREE (salvaged)
- 16 bolts with washers and nuts - $.50
- 3/4"conduit (about 2') - $2
- springs (13/16ths diameter) - 2 for $2.79
- allthread and nuts - $4.12 including an extra nut (in case one got lost)
- plywood - FREE (leftover)
- two 20" bikes wheels - FREE (salvaged)



Including the conduit and nuts and bolts I already had in the garage I paid $9.22 for this trailer. $4.12 of that was for a jig which I'll use again, and I still have one spring left (valued at $1.39) so it actually only cost me $3.71! That's one heck of a bargain!

The trailer took about 8 hours to build, including designing it and learning how to drill metal correctly. A handy person shouldn't have any problem doing this in less than 5 hours.

ON BEDFRAMES

Bedframes are a wonderful raw material for making things. People are always throwing them out, so I can keep a supply of them in my garage and replenish them as they get used.

The material itself is sturdy and easy to work with. Its universal size (1.5" angle iron) makes building from multiple frames easy as building with one, which is seldom the case with salvaged conduit. Also bedframes are not galvanized like most conduit, which is good if you're welding. The flat surfaces make it easier to bolt parts together. They also have durable paint which is not prone to wear and protects them from rust.

So when you run across bed frames, bring them home. You'll most certainly find them useful down the road.

Whenever I build something out of bed frames the first thing I do is take the frames apart. This means grinding off the rivets—I use an angle grinder with a metal cutting wheel—and then knocking it all apart with a hammer. I usually save the fixtures at least until I'm done. I hold on to the little corner brackets indefinitely.

TIP: For the angle grinder, I've found that cheap cutting wheels work best. They're usually thinner than expensive ones, so they cut faster and they seem to last just as long.

ON EYE & EAR PROTECTION

As someone who avoided using eye and ear protection wholeheartedly for many years, I will now wholeheartedly endorse it. Let me say: Unless you think you'll enjoy a constant ringing in your ears, protect them.

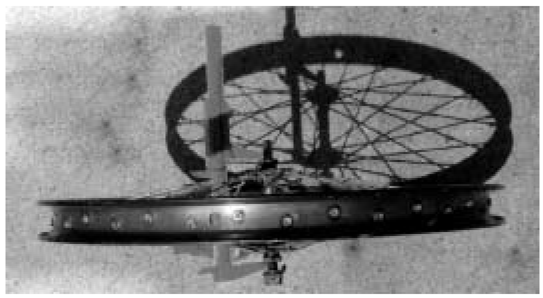
I don't like earplugs much, so I use an $8 set of ear muffs. I toss them on when I'm doing something loud and take them off when I'm done so I can hear my music.

I started wearing eye protection on a regular basis after my sister had a close call with her eye. She was cutting a metal strap and it popped up and hit her square in the eyeball. So now I wear glasses. That $2 worth of safety glasses could save you from painful eye injury and surgery that you probably can't afford.

SIZING YOUR TRAILER

Before making your trailer, figure out how big you want it to be. I decided to make one that would hold a 30 gallon plastic tub. The bottom of the tub measured 24x14", so I went with that. (This was a bad idea. I should have measured the top, which was wider.) You have to add the width of the wheels, since the tub will rest between them, as well as the width of the material.

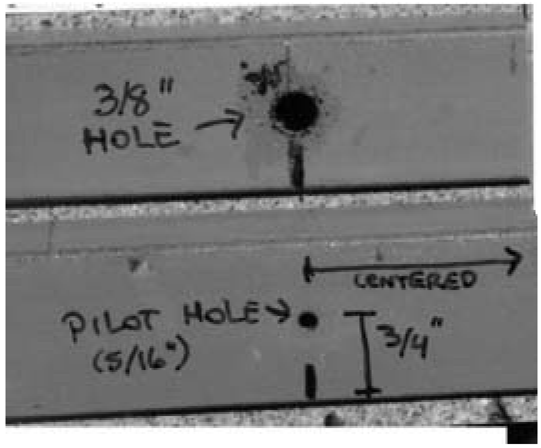
I grabbed some 20” wheels I had in the garage. Both needed 3 5/8” between the axle dropouts. You also have to add 1.5” per side to account for the width of the angle iron. So your original width is 14” to which you add 3 5/8 + 3 5/8 + 1.5 + 1.5 = 25.25”. That is the total width of this trailer. You’ll need four pieces of bed frame the length of the trailer (24”) and two pieces the width of the trailer (25.25”).



ON DRILLING

Drilling metal is a lot different than drilling wood. With wood, you put the bit where you want the hole and pull the trigger. When you’re drilling metal, it’s a good idea to center punch where you want the hole to be. There’s a tool for this, but I use a hammer and a nail or screw. I put the tip of the nail where I want the hole and strike it hard. This makes a little divot that keeps the drill bit from wandering while you try to get the hole started.

If you’re drilling a big hole (like the ¼” and 3/8” holes we’re drilling for this trailer) you’ll want to start out by drilling a small pilot hole. Again, this will help keep the larger bit from wanting to wander as well as creating a guide for the larger bit to follow.



With steel you don't want the bit turning as fast as it will go. You want a slower speed with just enough pressure for the bit to cut. You should also put some oil in the hole once you get it started to prevent the bit from overheating and becoming dull.

The oil will smoke as the metal heats up. This is normal, so don't worry. After you've drilled a pilot hole, you can drill a bigger hole. I drilled the holes in this frame three times each, starting with a 5/16" and moving up by steps from there.

One more thing, always keep the pressure on the drill bit going straight down. The bits are very hard so they can keep a sharp edge, but that makes them very brittle and sideways pressure will break them in a hurry.

I would much rather weld my frame together than bolt it. Welding is stronger and has less give. You don't have to worry about nuts coming loose either. On top of that it's easier and faster. However, since I know that not everybody has access to a welder, I decided to design a trailer that can be built without welding.

THE FRAME

Let's get down to building the frame. Take your four identical (lengthwise) pieces and mark the center of them. Then mark 3/4" (halfway) from the edge on the previous mark. This is where the axles are going to go. I measured the axles on my wheels and they were 3/8". Drill a 3/8" hole centered on each mark.

Once you have the axle holes drilled, you'll want to make them into a slot. Use a square to mark lines from the edge of the hole to the edge of the metal. Use a knife or something similar to scratch the paint so you get a thin line. When you cut, the line should be your outside edge if you're cutting with an angle grinder. It doesn't make as much difference with a hacksaw, since the blade is very thin.

You want the axle slots to be as accurate as possible so you can get your wheels straight. Take your time with these cuts, make sure you get them right, and you will see it's not that difficult. You can always file a slot wider if you need to.

Once you have your slots cut, make a simple jig to hold it all together.

The jig does two things. It makes sure all the axle slots line up even if there was an error in measurement somewhere, and it holds all the pieces where they're supposed to be while you bolt it together. Remember, if the axle slots aren't in line, the wheels will sit crooked and pull the trailer to one side.

I was originally going to use a bolt with some nuts and lay out one side at a time, but for an extra dollar I went with allthread, so I could do both sides at once. With 8 nuts at 17 cents each my jig cost me $3.95. When the trailer is done, they can be used again for something else.

Put all the nuts and washers about where they should go. Put the other two frame pieces on 2x4s so they sit flat. Lay the lengthwise pieces on top with the axle slots facing up. Slide the allthread jig into the slots and start on one side, measuring everything. For me, it was 3 5/8" between the first two axle slots, 14" to the next one, and 3 5/8" to the last one. I tightened each one as I got to it.

Next it's time to drill. It's much easier to get your holes to line up if you hold your pieces of frame together and drill them both at once.

Again, start on one side. Drill the hole, bolt the pieces together, and tighten them by hand. I used ¼" bolts with nuts and lockring washers. Measure to make sure the distance to the next one is the exact same as the distance at the axle, then drill and bolt. Do this all the way around. Also make sure the distance from corner to corner (front to back) remains the same on both sides. After the whole thing is drilled and loosely bolted together, go back and tighten everything up.

To keep the frame from twisting, cut a piece of 3/8" plywood to fit. Mark spots for four bolts—one on each side. Drill them with a wood bit and then use it as a template to drill the frame. After bolting the plywood to the frame, remove the axle jig.

TOWING ARM

Next, put the wheels on. Stack up some bricks or wood under your trailer to keep it level while sitting on the wheels. Center a bike in front of it about the distance you want it from the trailer. Mine was about 9".

Take a piece of 3/4” electrical conduit and lay it against the side of the frame far enough forward of the axle to have room to get an adjustable wrench in there. Mark the tube at the front of the frame and put a 30 degree bend in it with a conduit bender.

If you don’t have a conduit bender, you could also heat the conduit and bend it, or bend it around a tree trunk or something round. Try not to kink the conduit, or it will want to unkink later (and break). Some hardware stores will bend tubing for you.

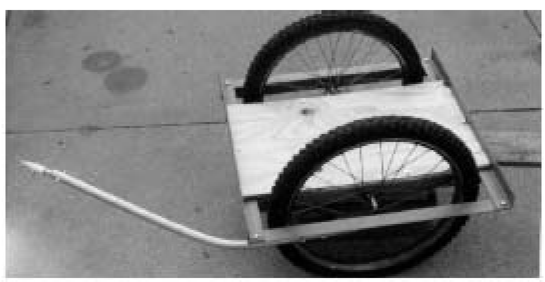
This conduit will be the towing arm that connects the trailer to the bike. The bend serves two purposes, it brings the conduit from the edge of the trailer towards the center where it will attach to the bike. Also, when rotated, it brings the conduit up to the level of your axle. It should bend a little behind

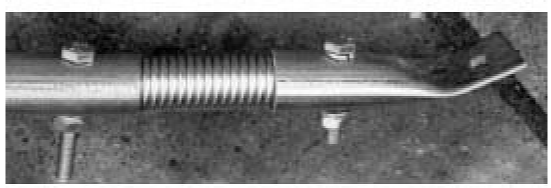
and slightly lower than the axle of your bike while your bike is straight up and down.

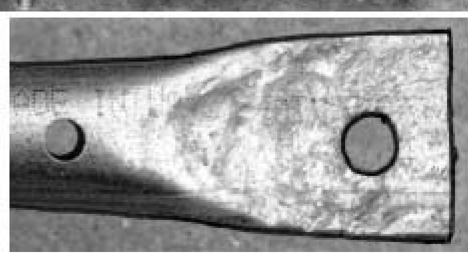
Mark the tube and cut it. Cut too long rather than too short. You can always trim a little more if you need to.

Once you get the towing arm positioned the way you want it, use two C-clamps to clamp it to the frame and drill two small pilot holes through the conduit and into the frame. Then take off the clamps and finish drilling all the holes to ¼”. While you’re at it, drill a ¼” hole about an inch or so from the other end.

Take a small piece of conduit and hammer about an inch of one end flat. You want the flat part at a slight angle to the tubing itself. Drill a 3/8” hole through the flat section, and a ¼” hole through the round section.



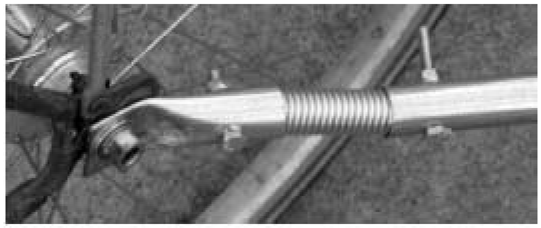


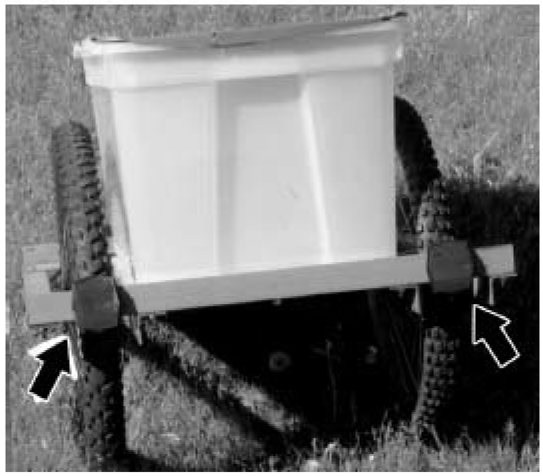


The flat section will be bolted to the bike frame using the axle on the rear wheel. It needs to be attached to the towing arm with a flexible joint to allow the trailer to follow the bike around corners and over bumps.

I decided to use a spring since that's what was on the manufactured trailer we bought when the kids were little. Aside from the jig, this was probably the most expensive part of the trailer at $3.29 for a pack of 2 springs. The springs have a loop at each end. Slide them into the conduit and put a bolt through the drilled holes and through the loop. Do the same with the short piece.

This joint could be made flexible in other ways. A thick piece of rubber tubing or perhaps even a chunk of an old garden hose could be substituted for the spring. Put it in the conduit when drilling your ¼" holes and drill the tubing at the same time. Run bolts through it to hold it together.





Once you have that flexible joint figured out and created, your trailer is done!

Well, it could be done. If you've designed your trailer for using a tub, you may want to permanently attach it.

To attach the tub, cut pieces of lath (1.5" x ½" wood strips) to fit lengthwise in its bottom. Pre-drill the lath (it splits easily), put them in the tub, and then put the tub on the trailer. Drive three sheetrock screws through each piece of lath, the tub, and into the plywood platform of the trailer.

Now remove the nut from your rear wheel axle, slide the connector on, and put the nut back on, with a washer to prevent the connector from getting marred. Load up your trailer and go for a ride.

These pictures were taken before a tub was permanently mounted.
Pictures by Esther & Jed & Matte

One more thing you may want to do is to drill some holes on the rear and attach a couple reflectors.

BUYING NUTS & BOLTS

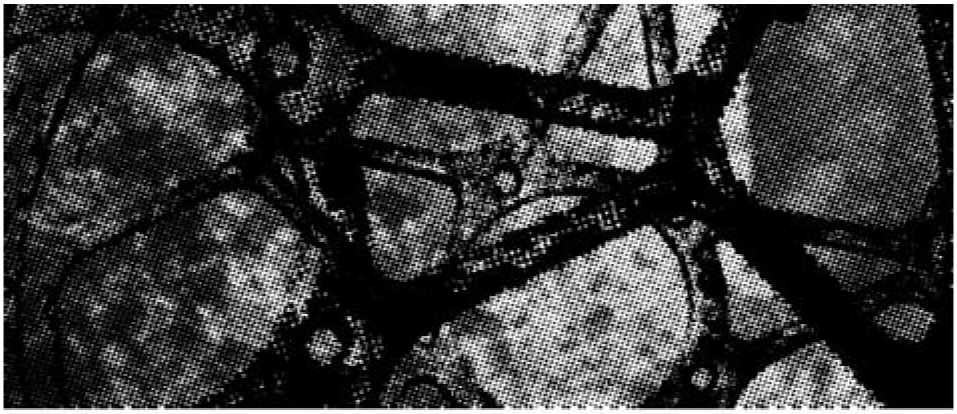
Here's a tip for buying nuts, bolts, washers, and other assorted hardware. When you need some hardware for a project, don't automatically run to the

drawers at the hardware store where everything is individually priced. Often you can buy a whole bag for the same price as a few individual pieces.

Some places will have a “bulk” section where you can buy hardware by weight. This is often cheaper too. Also keep an eye on the clearance shelf. I’ve picked up damaged boxes of nails and drywall screws for next to nothing.

Shop around a bit before you buy. If you can buy larger quantities for about the same price, do it! You’ll be astounded at how convenient it is to have a small stockpile of hardware.

This method will only work if you can find your stockpile when you need it. I bought a set of 16 small plastic storage bins. You can get stackable ones, or the ones that hang on the wall. They keep everything organized and handy. It’s not the only way to keep things sorted, but it works well for me.



1st test run with welding equipment as cargo (ironic ain't it?)
photo by: Esther

BED FRAME BICYCLE SIDEHACK

Instead of using my traditional method for building a sidecar with bike frames, I wanted to try building one like the bed frame bicycle trailer but minus a wheel.

After choosing a bike, find a wheel for the sidecar. I chose a 26” front wheel, so let’s proceed with those measurements. However, you can adjust these measurements to fit the size of your wheel.

Next, grab a length of bed frame. If the outside diameter of the wheel and tire is 26”, you need a little more than that for clearance. The cross members on each end were 1.5” wide, which put the frame at 29”.

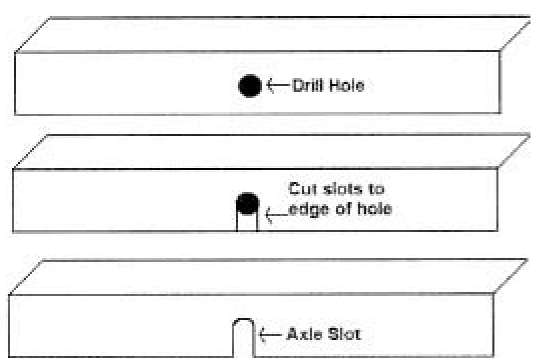
Cut a 30” length of bed frame to leave a bit of breathing room. The remaining part of the bed frame that I used was about 45” long. It seemed like a good length for a sidecar, so I decided to use those two pieces as the outside edge of the trailer.

Slot these in the same way as the bed frame trailer. Mark 15” from the end and drill a 3/8” hole halfway up the width of the bed frame (look at the bed frame trailer article if you’ve never drilled metal before).

Make cuts to the edges of the hole using an angle grinder with an abrasive cutting blade. I couldn’t find a 3/8” drill bit at first and I considered cutting the whole slot with a grinder blade. I think that would work fine.

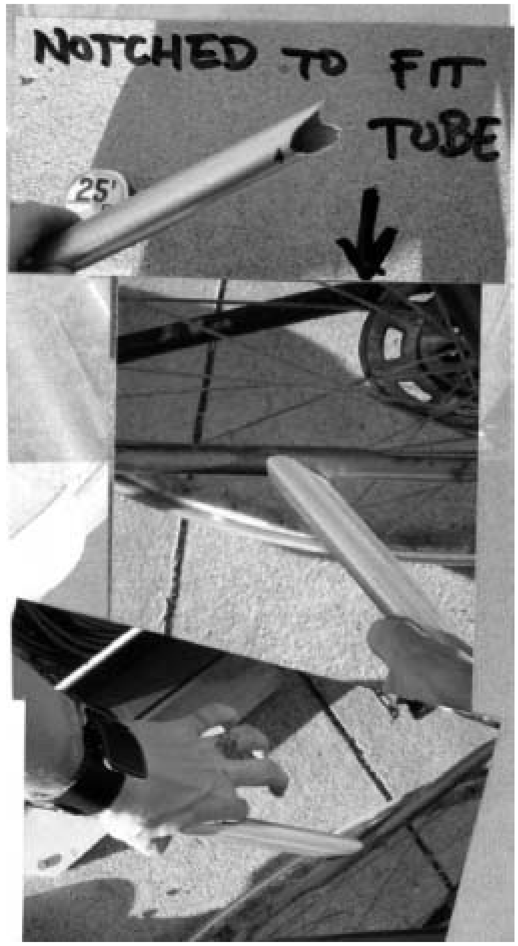
Once both slots are cut, put them on the wheel and tighten them down. Then grab a leftover piece of bed frame (mine was 22” long). Clamp this to the end of the two pieces to see if it would work for the width of the sidecar. If so, remove the wheel from the frame pieces.

One thing to remember when building a sidecar is that the sidecar will actually stick out further than the width of the car itself because you need space to pedal between the car and the bike.



For example, this sidecar has a platform that is 17” wide, but you have to add 5” to the outside of that for the wheel well. The whole thing needs to be mounted about 8” or 9” out from the body for enough room to pedal, which

puts you at 31” wide.



At this point, I set the whole mess up on 2x4s like I did for the trailer. This way, I can get accurate measurements, get it all squared up, clamp it and weld it. Building the platform for the sidecar is pretty much like building a long, thin bed frame trailer, except that only one side will have a wheel.

Grab a length of bed frame and cut another 45” piece for the other side. Then cut a 17” piece to go across the front of the sidecar. One of the bed legs worked nicely as the front section of the wheel well.

Lay all of this out on the 2x4s and lightly clamp everything. Then measure everything to make sure that the pieces that should be parallel are parallel and use a carpenter’s square to check that the other pieces are perpendicular to those.

Once everything looks good, clamp it all together and weld it. If you want to bolt a wood platform into your sidecar, I suggest that you drill the holes now. It's easier now than when the car is welded to the bike.

Now comes the tricky part: attaching it to the bicycle. I built my sidecar for the left side of the bike. This is not the normal side. Just take note of the fact that a sidecar on the left is not normal and that you should consider building it on the right.

Put the wheel back in the slots and tighten it. Next, find something to put under the sidecar to keep it level while attaching it to the bike. I found that a recycling bin stuck under the bed frame rails worked perfectly. Afterwards, you have to stand the bike parallel to the car with some scraps of wood.

Measure between the rear wheel rim and the car. You can't have the bike leaning on the kickstand: when you weld the car to it, the bike will always be leaning that far! Put a scrap of wood under the kickstand, and another leaning on the other side to keep it from tipping over. I suggest leaning the bike a little *toward,* the sidecar. Not a lot, only a little bit.

Once you have the sidecar and bike set up, find some pieces of scrap conduit to connect the car to the bike. The first piece goes from the car to the chainstay. Make sure it goes far enough back on the chainstay that you still have room to pedal.

Cut a notch to fit the chainstay on one end. On the other end cut an angle to sit right up against the side of the bed frame. The next piece goes from the front inside corner of the cart to the neck. Make sure that your foot or knee isn't going to hit this piece while you're pedaling! The other piece goes from the top of the seat stays to the rear inside corner of the car. The first three braces are a straight tube welded at an angle.

Whenever possible, cut your piece to fit snugly against the other piece. If you

have a flat end of a tube meet up with only the side of a round tube, they don't have much contact and the weld isn't very strong. When you get that piece cut, tack weld it in place.

Until all the braces are set up, don't completely weld anything. You may run into problems and need to knock a piece out. For now, tack it all in place and then go back later and weld everything solid.

The next couple braces are a bit trickier because they need to be bent. One goes from the neck to the outside front corner. This one has only one bend. The other brace goes from the top of the seat stays around the back and down to the rear outside corner of the platform (not to the outside corner of the wheel well). This one has two bends.

These braces do two things: they make the sidecar rigid and they act as rails to hold items in your sidecar. If you want, you can also use them to make an enclosure for your sidecar.

Once you get all of those tack welded in place, measure again to make sure everything is still straight. Make sure that you have room to pedal the bicycle. If everything looks good, weld everything solid.

Obviously, there's more than one way to do this. Another method is to build a rail all the way around the platform of the sidecar and weld your braces to that. You could even make the rail out of bed frames and nothing would need to be bent.

Once all of the braces are welded solid, you should be able to take the bike for a test drive. I suppose now is a good time to mention that sidecar bicycles do not handle like normal bicycles. When you first try it out, take it easy. Go slow. When you turn towards the sidecar, your bike will want to lift the sidecar up (this is why the bike should lean a little toward the sidecar).

When you have some cargo in it, the weight will hold the car down when you turn towards it. Turning away from the sidecar is much easier, since it should keep you from tipping. Again, take some time getting used to the bike and realize that these things are built for hauling, not for speed.

If you're happy with the bike, now is the time for finishing touches. I would highly suggest rounding off all of the corners on the bed frames with an angle grinder or file. Right now, I have a nasty looking cut on my calf from when I moved the bike and the sidecar's corner caught me in the back of the leg. This isn't the first time it's happened.

You'll probably want to add some kind of floor. I happened to have a piece of chipboard I'd dragged home that was almost the right size. I don't have mine bolted on yet, so I hold it down with a couple of bungee cords.

PROBLEMS

As I already mentioned, the first problem arose from putting the sidecar on the left side of bike. Roads are usually raised in the center to aid in water drainage, which tips the bike and sidecar toward the right.

This might have been okay if I hadn't also neglected to lean the bike toward the sidecar when I put it together (the second problem). One or the other

probably would have been okay, but both made my bike always lean away from the sidecar and made turning toward the sidecar nearly impossible.

So, I was biking down a hill to work when I lost control. I started heading toward the curb. I tried turning left but nothing happened. I hit the curb and flew into a garbage can, sending its contents splaying over the sidewalk. The back wheel was bent and wedged against the chain stay. I stood on the rear wheel to get it straight enough to ride home.

After some time, I figured that I could put on some dropouts that were lower than the bed rails and use a 20” wheel. Long axle slots would even allow some room for adjustments. I used a scrap of the bedframe that already had long slots in it. I cut it in half and hammered each half flat. I tightened one on each

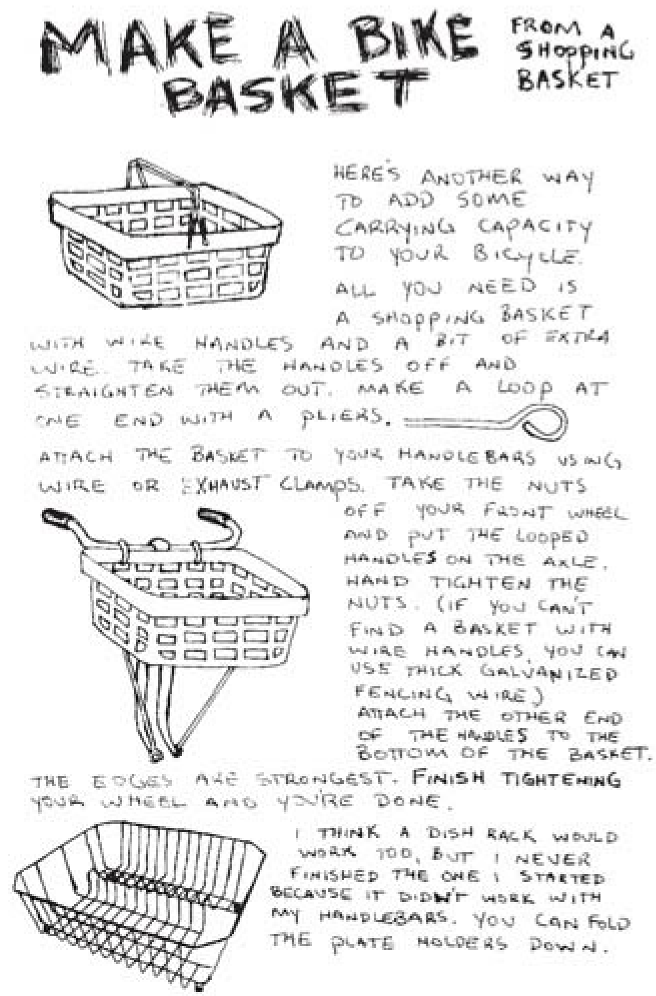
end of the 20” wheel axle and then slid them over the rails on the original wheel well, slightly forward of the original dropouts.

I clamped one in place, made sure the wheel was straight, and then clamped the other one in place. The slots on these didn’t actually go all the way to the end, so there was no way to remove the wheel once they were clamped in place.

I trimmed off the end with my angle grinder so that the slot would go all the way to the end and allow the axle to slip out. I slipped the wheel out and added another clamp to each dropout. Then, I welded the dropouts to the original wheel well. It sort of looked like those mass-produced trailers that have similar dropouts welded to round tubing.

Once the welds had cooled down, I put the wheel back on and then flipped the bike back over. It leaned a little bit too much so I slid the axle down the slot a bit to raise the sidecar. I took the bike for a test ride and it handled so much better.

The more weight you have in the sidecar the better the bike handles. However, I do think that it would handle even better if the sidecar was on the right side. But it’s not too bad and I’ve been riding that bike every day since.



ADJUSTABLE HEIGHT BIKE STAND

My friend Benjo and I got a space to set up a bicycle workshop, but we needed two or three repair stands. At $150+ a pop, we couldn't afford to buy them. We were sharing the space and having $450 of equipment sitting out, waiting to walk away didn't sound good.

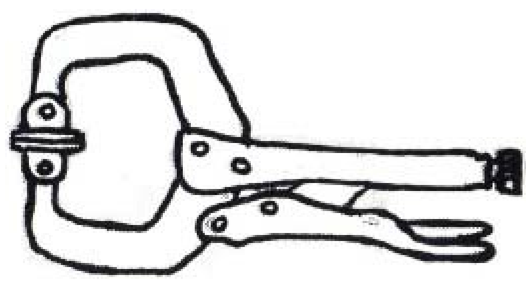
I couldn't find a design on the internet but I ran across locking C-clamps and the wheels in my brain started turning. I picked up a C-clamp, and within two hours had the whole thing worked out in my mind.

For $10, I built a repair stand with almost all the features of one that cost

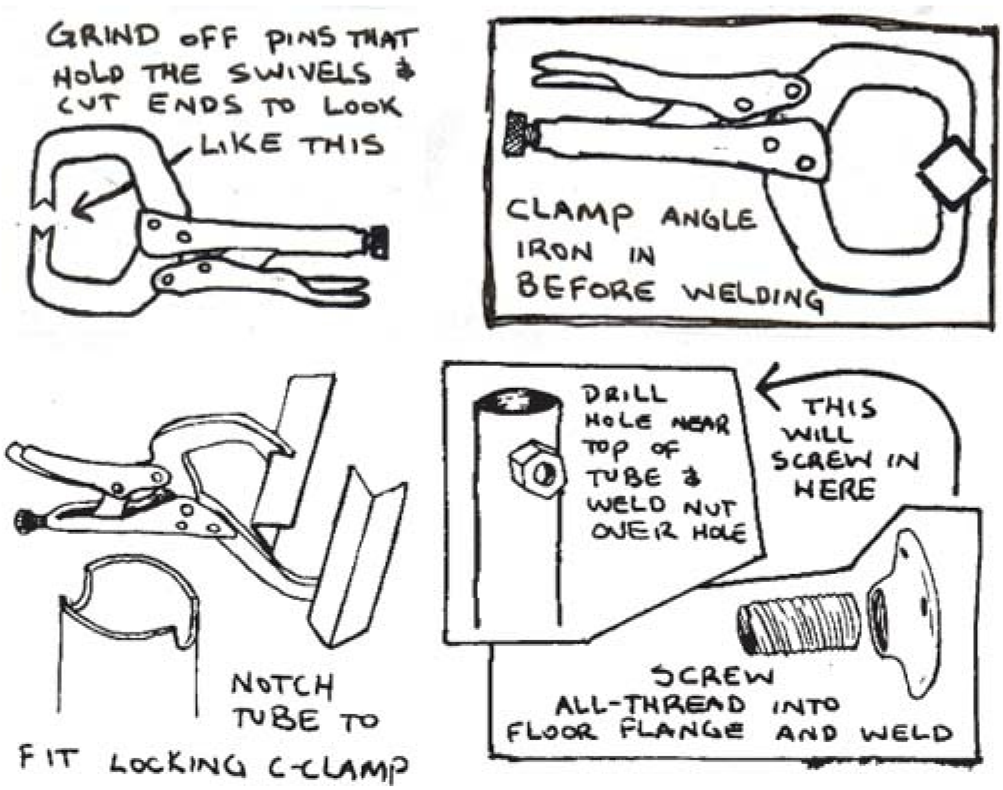
$150.

While I used a 3/4 flange and allthread for a handle, feel free to substitute what you have sitting around that might work better. You can use any size piece of conduit that won't bend under the weight of a bike, and another that fits inside of it without too much play. A square tube is fine if that's what you have around.

If you don't want or need the height of your stand to be adjustable, one piece of conduit will be fine. If you don't have different people of various heights using the stand, the project is much easier. Read "fixed height stand" at the end before continuing.



What you'll need:
- locking C-clamp
- two 4" long pieces of 1.5" angle iron
- 3/4" floor flange
- 1.5" floor flange (available in the plumbing section)
- 32" long piece of 1.5" conduit
- 24" long piece of 1.25" conduit
- 4" long piece of 3/4" allthread
- 3/4" nut
- old inner tube



Here's a hint before we get started. Just about everything we'll be working with here is either galvanized or chromed. On every area you're going to weld, grind off the chrome or galvanization. Both make welding difficult, and both give off toxic fumes when welded. Work in a well-ventilated area.

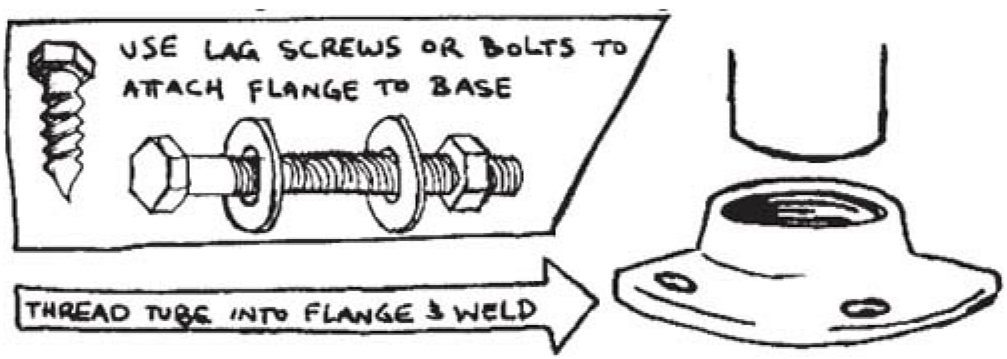
Start with the 6" locking C-clamp. Buy one with the swivels on the end, and grind off the pins that hold them on. Cut a notch to the hole on both sides. You'll want it to have a 90 degree angle to fit a piece of angle iron. Make sure you cut it so that the 2 pieces of angle iron meet when the C-clamp is closed.

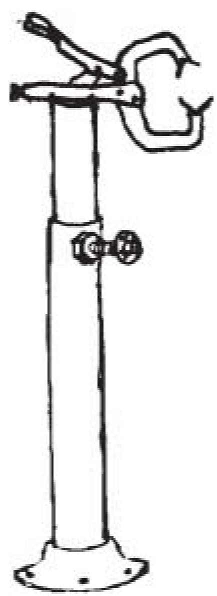
Mark the center of the 2 pieces of angle iron, center them in the clamp and lock it shut. Make sure everything is lined up and weld them to the C-clamp.

Grind a notch in your 1.25" wide conduit to fit the top handle of locking C-clamp. Position the corner of the bottom piece of angle iron to point directly at the ground. If it's tipped too far one way or the other, it'll be hard to get the bike to sit in it while you clamp it down. With my clamp, this meant that I

had to mount it to the conduit at an angle.

Grind one notch a bit deeper than the other, so when the wrench is in it, the angle iron will be level. Once you have everything the way you need it, back the screw all the way out of the wrench and remove it so that you don't accidentally weld it in place. Then weld the wrench in place.





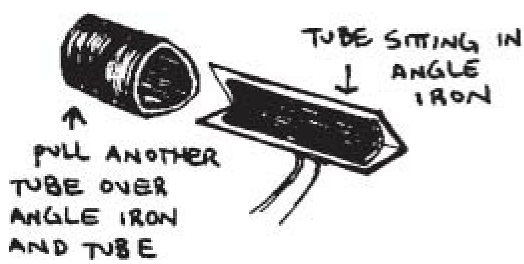
Hint: grind the notches out a bit at a time. You want them to be fairly snug. There will be a lot of stress on this joint, so you don't want it sloppy. Grind a bit out, see if the wrench fits. Grind out some more, see if the wrench fits, etc. until you have the wrench in there at the angle you need.

You have the top section of the stand made. Start the base by drilling a 3/4" hole a few inches from the top of the 1.5" piece of conduit. Leave the hole

small enough that a piece of 3/4” allthread could still be threaded in, but not pushed.

Put a large nut on the allthread, then thread it into the hole. Tighten the nut by hand against the conduit to hold everything tight and square and weld the nut to the conduit. Weld one side of the nut, turn the allthread, weld another and turn it again, etc. This keeps the allthread from being welded to the nut.

Hint: Be VERY careful not to get the conduit too hot and punch a hole through it, or run any metal through the hole you’ve made. Keeping your hole close to the top makes it easier to file if a piece of slag falls in.



Thread your 4” piece of allthread into the 3/4” flange from the top, until it’s about ¼” from the bottom. Weld it to make a handle that adjusts the height of your stand. You can also use it to rotate the top part of the stand, which could come in handy if the stand is permanently mounted to the floor. After the nut you’ve welded to the conduit has cooled, smear a little grease in it and thread your handle in.

Mount your conduit to your flange. I found a flange that fit my 1.5” piece of conduit. The conduit wasn’t threaded, but it threaded in anyway. Then I welded it in place. If you don’t have scraps lying around, and have to buy a conduit anyway, you could buy a pre-threaded pipe that would screw right into the flange.

If you’re trying to avoid welding the base, you can get an EMT set screw connector. It’s a sleeve with threads on the bottom that tightens onto a pipe

with a couple set screws. Test fit everything at the store before you buy.

Bolt your flange to your base. You could use metal, wood, or just screw it right to the floor. If you're screwing it to a cement floor, drill a hole with a masonry bit first and use masonry screws or bolts with anchors. I screwed mine to a piece of scrap plywood about 24"x24".

To protect the bike from the angle iron, use bike tubes. Lay a 4" length of tube inside the angle iron, and then pull a 2" length over each end to hold the 4" piece in place. This gives you plenty of padding to protect your bike's paint and whatnot.

FIXED HEIGHT STAND

If you want a stand with a fixed height, you can skip a great deal of this. Instead of 2 pieces of conduit that fit together and tighten, pick the height you want, weld the modified C-clamp to the top and a flange, with base, to the bottom. You could turn this into a bench mounted stand by using a short piece of conduit and bolting your floor flange to your workbench.

If you're interested in attaching this stand to a work bench, check out the instructions for a quick release bench mount later in this book.

This repair stand spent a couple years at the shop being used on a regular basis and never gave us any problems. It was put through its paces and was never found wanting.

NIKOLAS' HOMEMADE GENERATOR BICYCLE

Nikolas built this machine out of an old stationary bike. His generator was actually the motor from an electric scooter.

When you turn an electric motor backwards it creates electricity. The trick is finding one that will create the kind of power you need. The motor Nikolas was using was rated at 24 volts although it came out of a scooter that only had a 12 volt battery in it.

That's pretty good, but volts without amps don't do much: It's the amps that do the work. Nikolas hooked up various motors to his drill and tested to see what kind of power they were giving. Some would give 50 volts of power but

only .0003 amps, which isn't enough to light a light bulb.

You want to find a motor that has a lot of torque over one that puts out a lot of speed. The motor from a scooter that moves a heavy weight at relatively slow speeds is going to work better than one from a fan that spins a lightweight blade at high speeds all day long. Engines that are meant to really do some work are the ones most likely to give you a decent amount of amps.

Although a friction drive isn't the most efficient, it is probably the easiest. Nikolas cut a slot in the part of the bike that normally puts tension on the front wheel to adjust how hard it is to pedal. To this he mounted the rear section of an electric scooter. Using that whole section saved him the trouble of building mounts for the wheel and motor. He mounted that section with the bicycle wheel touching the scooter wheel. The weight of the assembly held it in place, so he didn't end up needing to weld the parts together.

When you pedal the bike, the bike wheel rubs against the scooter wheel and turns it backwards.

His final modification to the bike was to weld a larger chainring on to the old one so that he could get the wheel turning faster.

Nikolas built the bike to power lights for his band, Breaksea Caravel. He had two 35 watt lights hooked up to it when I dropped by. The third 50 watt light was disconnected. He has a wooden control panel mounted to the handlebars with a switch for each light.

When I tried the bike out I learned something about how generators work: The more electricity you're trying to get from them, the harder they are to turn. When I was pedaling without any electrical draw it was easy, but when Nikolas started turning on the lights it got progressively tougher.

It felt like 70 watts could be pretty comfortable for a while. I read recently that

a person can usually keep up a pace that will put out about 100 watts. That's not much. One hour of pedaling will light a single 25 watt light bulb for four hours. That's a lot of work for four hours of dim light.

To put it in perspective, I pay about six cents for a kilowatt hour (kWh) of electricity. A kilowatt hour is 1,000 kilowatts for one hour. At 100 watts an hour it would take me ten hours of riding to make six cents worth of electricity.

Our bill for March shows us using 506 kWh of electricity that month. That's almost 16 kWh per day. It would take about 160 hours of pedaling to produce the electricity we use in a day.

A bicycle generator isn't the way to power your house. It's a good way to show people the kind of effort it takes to create electricity and perhaps encourage them to use less. Besides lighting up rock shows, that's been this bike's main use.

We discussed the possibility of using the bike to charge batteries. The one drawback was needing to figure out how not to overcharge it. Also, in order to run most household electrical you need a 120 volt alternating current (120V AC), whereas generators put out about 12 volts direct current (12V

DC).

The lights on Nikolas's bike work because they were originally made to be powered by a car battery, which also puts out 12V DC. To run household appliances you would need an inverter to convert DC to AC. You can get around needing an inverter by looking for appliances for RVs that run on 12V DC.

FRONT WHEEL DRIVE RECUMBENT BIKE

There's nothing particularly practical about this bike. It has a low center of gravity, which makes hauling stuff nice, but it doesn't have a lot of extra room for cargo. I mostly built it for fun.

Start out with a standard step-through frame. Straight top tubes will probably work better than curved ones.

Remove the seat, the front wheel, the cranks and chain, and the handlebars.

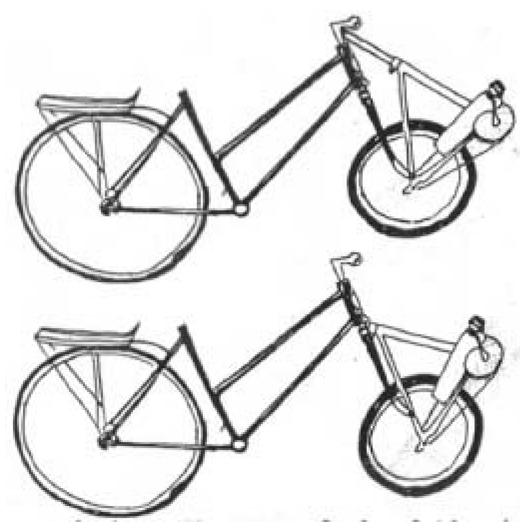
Next you'll want to cut the rear triangle off a smaller bike. Cut the rear triangle off in front of the seat tube and bottom bracket, like in the picture. This is important because you want to keep the drive train intact. Remove fenders and racks, but the chain guard can stay.

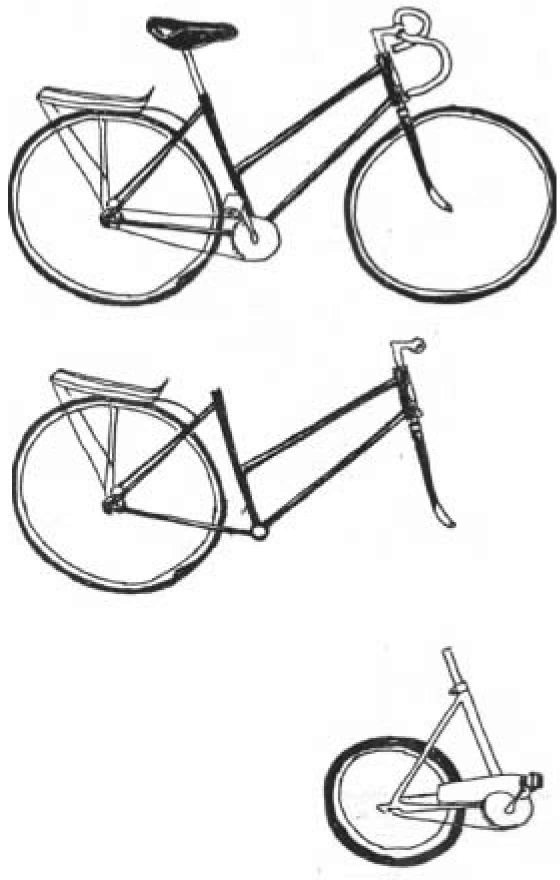
Try to find one with multiple gears. If you're tall, a bike with 24" wheels should work for you. If you have shorter legs, use the rear triangle from a 20" bike. Although some adjustment is possible, the size of the wheel to a certain extent dictates the distance from the seat to the pedals.

Next, attach that rear triangle to the front of the step-through frame.

There are a couple of ways to do this. Start by tipping the rear triangle backwards and slipping the seat stays between the dropouts on the front forks. Then you need a way to attach the seat tube or post. I prefer the method in the second illustration. Slide the dropouts far enough up the seat stays that the top of the seat tube can be attached to the top of the forks.

The other method is to extend the seatpost until it comes into contact with the neck. This way the distance to the pedals can be adjusted by shortening or lengthening the seatpost. The drawback is that the neck can never again be removed, making maintenance impossible.





The tricky part is figuring out if the pedals are the right distance. Put the front end together and then barely sit on the top tube (putting no weight on the bike), and then reach for the pedals with one foot while holding yourself up with the other.

Take into consideration that when you turn, the pedals will turn too. This means that one will get closer and the other will get farther away. You want the pedals close enough that when you turn you can still keep your feet on them.

Once you have it adjusted, weld it together. Weld the fork dropouts to the seat stays and the seat tube to the fork crown or neck (this will only work if you have a steel neck). Make sure the wheel is straight and centered in the forks and the rear triangle. You want everything as straight as possible when you weld it up.

The rest is details. Find a nice, wide seat and attach it to the top tube. One way is to put a seatpost clamp on the top tube and bolt that to the seatpost clamp on the underside of the seat. I also used a large hose clamp to hold the front of the seat down. Depending on your seat, you could also weld it directly to the top tube.

You'll also want some kind of back to the seat. Something padded is nice, but a piece of wood will work fine. Attach it to the bike using conduit clamps, one around the top tube and attached to the bottom of the backrest, and the other around the seat tube and attached to the back of the backrest.

I ended up using a couple of ape hangers for handlebars.

At this point you can hook up the gear shift and brake cables for the rear triangle, or you can enjoy the bike without gears and use the back brake.

Front wheel drive does take some getting used to. But once I got used to it I loved this bike and rode it every day.

CONVERTING TO SINGLE SPEED

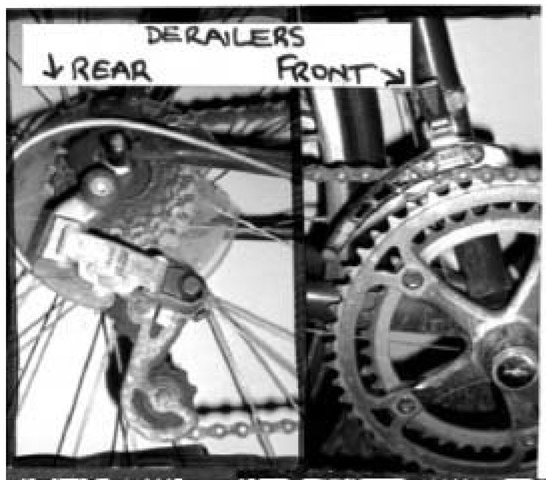
Building a single speed is about the simplest thing a person can do with a bike, eschewing anything that makes it complex. But sometimes friends take complicated bikes and through a series of even more complicated procedures, attempt to make it simple.

Part of this might be the pursuit of form over function. One of my friends was determined to make a single-speed wheel out of a standard ten-speed rear wheel with a five gear cassette. Rather than put the chain on the gear he wanted to use and leave it at that, he spent time trying to remove the superfluous gears to leave only the one he really needed.

His "simplified" bike caused him more problems than before and what could have been a free conversion ended up costing him many trips to the bike shop for a bike that he was never really happy with.

For good reason “messenger” bikes are the hot new thing. Such clean lines! No clutter! I’ll cover some options that will leave you with a stylish bike, but mostly I’m going to focus on how to cheaply convert a multi-speed bike to a single speed. The real reason to go single speed is simplicity.

When you remove the derailleurs and shift levers and cables, there is less to go wrong. If you never ride in inclement weather, this may not affect you much. My boss had a bike that he rode for 20 years without any maintenance, but only around at the park when the weather was nice.



When he gave it to me, the “sealed bearings” were no longer sealed, and no longer bearings. Everything else was still in good shape.

But a bike in the rain and snow, with road grit and grime all over everything won’t hold up long. Throw in some Minnesota winters with snow, ice, salt, and sub-freezing temperatures, and your moving parts don’t stand a chance.

But if you take off that derailleur and shorten up the chain to travel in a simple loop with no give, no bending, and no complications, that thing will keep working right through the winter. It will keep working until it’s about rusted solid!

If you have a road bike with horizontal or angled dropouts, converting your multi-speed to single-speed is simple. If you have vertical dropouts, like on a mountain bike, most of this will still apply.

Figure out what the most comfortable gear on your bike is. Practice riding without shifting. Figure out which speed is most comfortable to use all the time and make a mental note.

On single-speed bikes, I like a gear ratio a little above 3 to 1. For example, on the one I recently built, I'm using a 52 tooth chainring and a 17 tooth freewheel. Divide 52 by 17 and you get about 3.06 to 1. That's a pretty comfortable all-around ride for me. On my bike with a sidecar, I have a lower ratio to get up hills with a load—about 2.5 to 1.

The first step is to break the chain, so you'll need a chain tool. Put the chain into the chain tool, and turn it until the pin in the tool comes in contact with one of the pins in the chain. Keep turning it until the pin comes almost all the way out. Generic chain tools allow you to push the pin all the way out, after which it can be almost impossible to get back in. Remove the chain tool and flex the chain toward the pin that is sticking out until the chain comes apart.

Now remove the derailleurs. Some rear derailleurs can be removed by loosening the axle nut on the rear wheel. Others you'll have to remove or loosen a screw. Now loosen the nut that holds the shifter cable and pull the derailleur free of the cable. Remove the cable all the way up to the shifter and remove that too. The same thing with the front derailleur.

If you think you might want to replace the parts later, or use the assembly on another bike, it's a good idea to keep it all together in a Ziploc bag or something.

You want to find the gear setup that works best for you, but you have to keep the chain in a straight line. That means that the chainring you want to use should have the sprocket you want to use directly behind it. If the sprocket is off to one side or the other, the chain will bend to get from one to the other, and the chain will constantly be trying to work its way off the teeth.

Let's say you like riding the bike with the 45 tooth chainring and 13 tooth sprockets, but the 13 tooth is one sprocket over from the one directly behind the 45 tooth. You've got a couple choices. You can either move the chain over to the 52 tooth sprocket on the front, or move it over to the 18 tooth on the back. Either one of those will line up. Neither is exactly what you want, but you can probably learn to live with one of them. I've done a number of bikes like that and this is the simplest way.

If you’re not up for a compromise, skip ahead to *No Compromise!*.

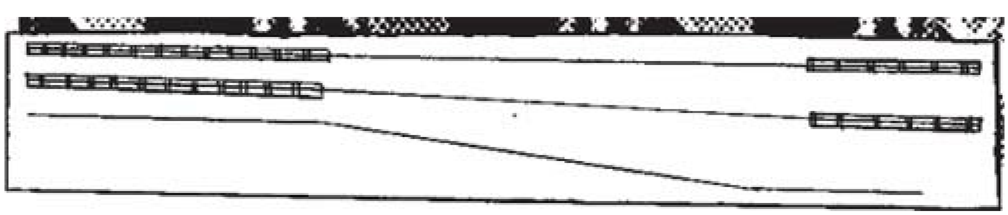
Set your chain on top of both the chainring and sprocket you want to use. Hold it tight while you stand behind the bike and look down the chain. It should look perfectly straight all the way from the sprocket to the chainring. Take a look at the illustration. The line down the middle of each “sprocket” represents the chain.

You can see on the second one that it has three straight lines: one on the chainring, one on the sprocket and one between the two. This is shown even more exaggerated in the line next to it.

Once you get a straight chain line, shorten your chain to the correct length. Slide the rear wheel all the way back into the axle slots. Put the chain on the chainring and sprocket and pull it tight so that one end overlaps the other. Hold them side by side with your finger where the one end overlaps the other. Generally they won’t line up perfectly, so shorten the chain a little more to get them to line up.

This is fine because you’ve got your wheel all the way back and it has room to come forward a bit. There are inner links and outer links in a chain. If the end of your chain is an outer link, you’ll need to break the chain at an inner link so that the chain can go together.

Use your chain tool to remove the short length of extra chain, and then use the chain tool to connect the ends.



Once you've got the chain put together, all you have to do is put it on the chainring and sprocket, hold it centered and tight while you tighten the axle nuts. Voila! Single-speed bike!

NO COMPROMISE!

If you want what you want and nothing else will do, there are ways to avoid compromising your gear ratio.

You have to move something. One way to do this is to move the wheel over a little bit.

To move the wheel to the left, put a couple washers inside the dropouts on the right. To move it to the right, put a couple washers inside the dropouts on the

left. This puts the wheel off-center in the rear triangle. This shouldn't significantly affect the way the bike rides, but it does make it so that your rear handbrake will not work.

The better option is to move the chainring. If your chainrings are welded directly to the spider or crank arm, you can use an option we've already discussed or track down a better crank with interchangeable chainrings.

If your bike has interchangeable chainrings, figure out which way you need to move the chainring to make it line up with the desired sprocket. Remove the crank from the spindle with a crank puller.

Once the crank is removed, remove the chainrings from the spider. There should be five little hex socket screws with T-nuts holding them on. Take them off using a hex wrench and your fingers. If that doesn't work, use a screwdriver wide enough to fit the slots on the T-nut. Once you get them all removed, the chainrings will come off. If you have one small chainring that is bolted directly to the crank spider, remove that too.

If you don't want to buy any parts, rearrange the chainrings: Put the medium sized one on the outside and the large one on the inside. If you'd prefer to have the chainring you need on there, you'll need shorter T-nuts. Buy a set of single chainring bolts or shorten the T-nuts you already have with a file or grinder.

Tighten the bolts with that large screwdriver. Hold the T-nut with your large screwdriver while you tighten the bolt. Get those bolts very tight and follow the instructions above to set up your chain.

One last jury-rigging option is to replace your gear cluster with a single speed (BMX style) freewheel. You can do this with most older multi-speed wheels. In order to make this work you'll have to do one of two things. You'll have to re-dish your wheel, or get a chainwheel in very close to the bike so it will line

up with the freewheel. This usually involves buying a shorter spindle for your bottom bracket, and using a small chainwheel that clears the chainstay. It's not my favorite method, but I've seen it work.

Another option is to buy a single speed rear wheel. That's what I've done in the pictures. I found that sweet Schwinn Le Tour frame in my friend's neighbor's garbage. You can get a single speed wheel with a flip-flop hub for under $150. The "flip-flop" hub is threaded for sprockets on both sides. One side is a fixed gear and the other is a single speed (BMX style) freewheel.

You can also put a freewheel on either side, giving the option of different number of teeth on each side. Figure out the gear ratio you want, but instead of finagling the gear ratio out of your 5 speed rear wheel, go to the store and buy the correct sized freewheel to go with your chainring.

Spin the freewheel onto the threads on the hub clockwise. This is easy to remember because if you turn it clockwise, you can turn the freewheel with the teeth. If you try to turn it counterclockwise, the teeth spin and it won't work. You don't need it terribly tight because when you pedal, it will tighten. Get it as tight as you can by hand. It will tighten the rest of the way when you pedal. Set it up as above, making sure that the chain line is straight.

VERTICAL DROPOUTS

If you have vertical dropouts there's potential that you won't be able to get your chain tight without making some modifications. There isn't room to adjust the length of the chain, so if things don't line up perfectly the first time, you have to figure out a way to make it work. There are a few ways to do this.

Adding or subtracting a tooth on one of your sprockets can make enough difference. But it can be a pain to disassemble and acquire different sprockets. The free options might make you a little queasy; involving taking a grinder or file to your bike.

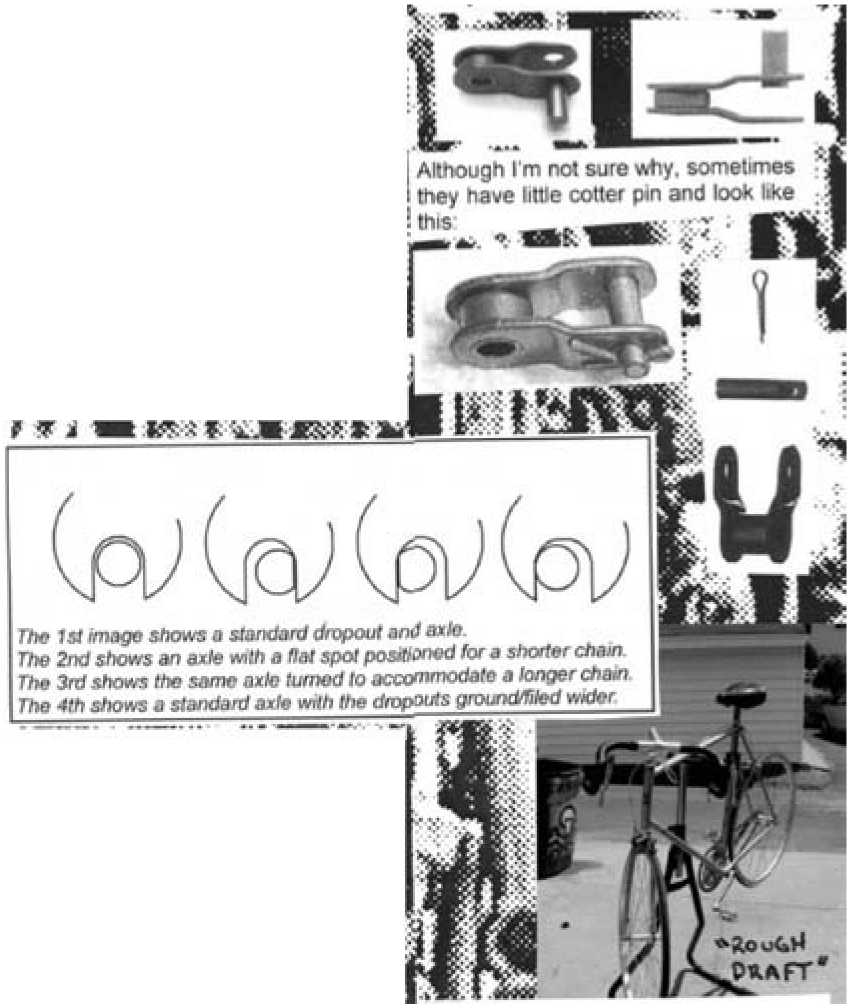
Option 1: file flat spots on your axle. The flat spots need to be in the same

place on both sides. Depending on which way you turn the axle, this gives you a little bit of space both forwards and backwards.

Option 2: grind your dropout wider. You can't go too far with this without losing strength and space for the nuts to tighten against, and once it's done there's no undoing it. You can get a new axle for your wheel. Getting new dropouts is rather more involved!

Your last option is to find a half-link, so you can remove one link at a time, instead of a set of two. They look like the photo to the right.

This will almost always do the trick, but they can be difficult to find. Many people haven't heard of them so your bike shop proprietor may give you funny looks when you ask for them. However, larger hardware stores sometimes carry them. Look in the bulk bins where you can buy individual nuts and bolts.



CONVERTING TO A FIXED GEAR

If you want to take building a single speed one step further and build a fixed gear, there's really not much more to it. The main difference is how the sprocket is attached, and how the bike rides. A fixed gear bike has no freewheel, so you cannot coast; no coasting up to a stoplight, no coasting down a hill. When the bike is moving, your legs are moving.

When you're putting the sprocket on a fixed gear, you screw the sprocket on first. It screws on in the same direction as a freewheel. Unlike the freewheel, you need to get it on tight before you start riding, because a lockring holds it on.

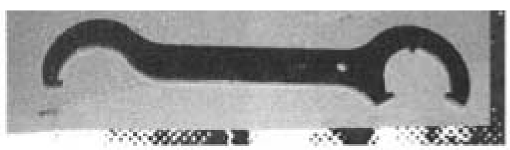
There's a tool for tightening on sprockets called a chain whip, but you can use

a different method without one. Put the sprocket on the hub and the wheel on the bike with the chain on like you would take it for a ride. Hold the front brake while putting pressure on the pedals like you're trying to go forward. Only pedal forward, and this tightens up the sprocket about as tight as it's going to get.

Put on the lockring. I prefer to have a lockring wrench for this. It can be done with a large channel lock but I am skeptical, because the lockring needs to be really tight. If you insist on using channel locks, here are some tips.

Channel locks are directional; they work better in one direction than the other. You want to put them on in such a way that when you pull (or push) it closes the wrench tighter without having to squeeze the handles together. If at all possible, get the corner of the jaw into one of the slots. This will make the wrench act more like a lockring wrench.

Lockring wrenches look like this.



The protrusions fit the slots of the lockring. Some fit into every slot, some only have one protrusion. Both will work fine. The lockring screws counterclockwise, the opposite way as the freewheel. Screw it on as far as you can by hand, and use your lockring wrench to tighten it. Get these things tight!

When you're first starting to get the sprocket or lockring on, never force it. With thread diameters this large, it's very easy to get things a little off and start cross-threading. You'll know you've started cross threading it because it will almost immediately be difficult to turn. Back it all the way off and start again. If you try to force it, you'll cut new threads and most likely ruin your hub. And now the question everybody is going to ask: "Can I convert a freewheel hub to a fixed gear hub?" Yes, you can!

Remember the part about putting a single speed freewheel in place of a multi-speed cluster? The fixed gear shift works pretty similar. The chainrings have to be moved in close enough to line up with the sprocket. A fixed gear sprocket has the same threading as freewheels so it will screw right on. However, because a freewheel hub isn't threaded in two directions, you can't put a standard lockring on.

You can use another sprocket as the lockring. This was how fixed gears were

originally put together. Another option is to use the lockring from a bottom bracket. The adjustable cup on a bottom bracket has the same threading as a hub, so it will fit. But make sure you get that thing tight!

I'd recommend checking them occasionally, using brakes, and not trying to do a lot of braking with the pedals.

PROS AND CONS

I wrote the following when I was riding a fixed gear. I don't ride fixed gear anymore. I wish I could; I really enjoyed it, but my knees won't let me. Your knees weren't meant for the kind of stresses that braking with a fixed gear puts on them.

As fixed gears have gotten more popular, I've read more fixed gear mishaps. These mishaps tend to happen as you're getting used to how a fixed gear behaves. They usually involve the pedals hitting something and throwing the rider; taking a corner too fast, the pedals hit the pavement, hopping a curb and the pedal hitting the curb.

There are stories about people who couldn't stop fast enough and ran into something. If you can't help riding around absentmindedly, a fixed gear might not be the right bike for you. You need to be a bit more attentive to your surroundings and your bike when you're riding fixed.

The other thing I hear about is knee trouble. That's when I quit. I'd rather enjoy riding my bicycle than ride around in pain, until I can't ride anymore.

I originally switched to a fixed gear, because I was tired of gearing problems. I saw all the messengers riding around on what was apparently a single-speed bike, and decided that was for me.

It solved another problem: perpetually maladjusted brakes. But the idea of paying $150 to convert a $12 bike didn't really appeal to me. Trying to find cheaper ways to do the conversion, it seemed that the only way was to buy or

build a wheel. I left one brake to keep working and adjusted—a feat even I could keep up with fairly well!

I rode that for a while, and after reading up some more on fixed gear bicycles, and test-driving a Trek track bike, I decided to take the plunge. I bought a fixed/free flip-flop wheel for $109 with another $40 for a cog, lockring, tape, tube and tire. I carried it home a happy man.

After riding fixed gear for a while, I was quite taken with it. I never had the adjustment problems some people complain about. When I converted my ten-speed to a single speed, I decided to ride it like it was a fixed gear, and never stop pedaling; pedaling around corners, down hills, and when coming to a light.

I think this helped out a lot when I put that fixed wheel on. A week after putting the fixed wheel on, I took a turn too sharp, smacked my pedal on the curb and was tossed off my saddle. I've smacked my pedal a couple times while squeezing between a line of stopped cars and a curb, but it usually doesn't even slow me down now. I've done much worse on a multi-speed. Hint: it's involved handlebars and a rear view mirror. OUCH!

I feel that I have much better control of my bike. I don't have to go for the brakes every time I need to slow down. When coming up to a corner, red

light, or obstacle, I pedal slower. If I come up to a corner too quickly, I can continue adjusting my speed around the corner. I have a front brake, just in case I need to stop fast or don't feel like giving it the effort. There have been times when a car has pulled out in front of me and I instinctively stopped the bike by applying pressure to the pedals. I probably stopped faster than if I had thought to go grasping for the brake lever instead.

I feel more in tune with what's going on with my bike, and the environment around me. I've learned to pay more attention to what is coming up. If there's a red light ahead, I slow down a bit. I watch what cars are doing ahead of me, and ride more defensively. Say you're going down an unfamiliar dirt path: You can keep your speed down a lot easier even if it's a pretty good incline. In the rain or snow, a hand brake will often slide along the wet rim, or lock up your wheels and send you sliding.

When you come up to a hill on a fixed gear, all you can do is get a good start, and hit it with all your strength. At first this is incredibly difficult, but the longer you do it, the more strength you will have. I don't waste energy trying to make the climb more comfortable, I condition my own body to handle hills.

The bike puts the focus on you. You've stripped it to bare bones, and if you make it up that hill, it's not because you've got a great bike, it's because you've pedaled hard and forced your way up the hill. If you pedal 200 miles, it's you doing the work.

Riding a fixed gear is better exercise, because you're not constantly taking breaks. You're forced to keep pedaling, keep your heart rate up and keep air and blood moving.

WINTER BIKING

Many of us have some sort of regular job, and most of us have to figure out some way to get there no matter what the weather. In this chapter, I'm going to go over some things that will hopefully make it easier to ride your bike to work and other places in relative comfort year-round.

SPRING/FALL

In the spring and fall, it's all about preparing for rain. Fall is my least favorite time of year to ride because the weather is so unpredictable that it's hard to know what to wear. I try to watch the news for the weather before I leave in the morning.

I watch the weather and decide if it's a day for shorts and a t-shirt or something heavier. Often it'll be cool in the morning and warmer in the afternoon when I get off work. So a lot of times I'll end up carrying my long sleeve shirt or jacket home, stuffed in my bag, tied to the bike, or folded in half around the strap of my bag.

The main precaution I take during the fall is to always have extra clothes with me. I have dry socks and boxers stashed in my drawer at work for rainy days. I also keep a baseball hat or glasses in my bag in case I get caught in the rain, because I hate getting water in my eyes.

I don't really do much in the way of trying to keep dry. I could wear a rain poncho, and that would keep parts of me dry. But rain clothes are hot and then I'd end up sweating and getting wet from underneath.

I get tired of having wet boots this time of year because they take a while to dry. Canvas shoes would probably dry quicker. Slacks will dry faster than jeans. Though having to put cold, wet pants back on at the end of the day probably makes little difference if you're going back out into the rain.

As the weather gets cooler I often add a pair of thin cotton gloves, a knit hat, and a flannel to the things I carry in my bag. It sounds like a lot to carry, but pretty soon you'll be wearing those extra layers instead.

WINTER

People tend to really freak out when they find out that I bike year-round in Minnesota.

To me it's silly. No matter what time of year you ride, you have to dress for the weather. The cold might be even easier to dress for than the heat. When

it's cold you can keep adding layers. When it's hot, you can only take so many layers off.

Perhaps the reason I don't think winter bike commuting is so terrible is that I started commuting in the winter. One day on my way to the bus stop I found a bike in a snow bank. I've been riding ever since.

Now, I think about all the time that motorists have to spend in the cold, or at least all the time that I would have to spend in the cold if I commuted by auto. I think about going out early in the morning to scrape the frost off the windows so I can climb into a cold car that won't warm up until I'm almost all the way to work. I think about shoveling off driveways, or working on a car in the freezing cold and standing out in the cold to fill up the gas tank.

Winter biking takes some preparation, but it doesn't take a lot money. The main thing is to keep warm without soaking yourself with sweat. It's a tricky medium, because when you first step out the door you feel cold, but after riding for a few minutes you warm up quickly.

The harder you ride, the warmer you get. And the problem with sweat is that it will cool you down in a hurry when the temperature starts getting low.

So here's what works for me:

CLOTHING

LEG WARMERS

One of my first lines of defense against the cold is a trick my friend Nikolas taught me. I cut the toes out of a pair tall socks, and pull them up over my other socks to cover my entire calf. This works when you don't want to put on pants yet, or after you're wearing pants but don't want to start with the long johns.

PANTS

When it first starts getting cold, I don't like to give in too fast. I like to keep wearing shorts as long as possible. Putting on pants means admitting that winter has arrived.

When you start wearing pants, you've got to do something to keep them out of your chain. I've ruined a lot of work pants thinking I could hop on my bike for a few blocks. If your bike doesn't have a chain guard, you're going to want to roll your right pants leg up high enough to miss the chain, or strap it to your leg tight with a rubber band or Velcro strap. You can also use a safety pin or tuck your pants leg into your sock. I always think it's cool to see people walking around with one leg rolled up, because I know they're bike riders.

LONG UNDERWEAR

I own cotton long underwear bottoms and wool ones. Both are military surplus. In most cases I prefer the wool ones. Wool shouldn't be washed as often as other materials. This may sound gross, but after you've worn it for a day or two, your body oils soften it up and make it less irritating. Also, there are new wools which are much more comfortable than the wool you may remember wearing years ago.

Cotton ones are good too. I like the military style with a button up front and adjustable ties. They fit a little looser than the honeycomb style that you always see, so they don't get twisted up and your drawers don't bunch up underneath. They work better for trips to the bathroom, too.

For tops, I get cheap long sleeve cotton shirts from the thrift store. Although they look cool under a t-shirt, they're much easier to remove if they're over your t-shirt.

T-SHIRTS

Not much to say here. I wear a lot of t-shirts. One thing I've found really helpful when it gets cold is to make sure your first layer fits tight against your body. That way you don't end with a cold breeze finding its way to your skin. This winter I've been wearing sleeveless athletic shirts, and it's really been helpful in keeping me comfortable.

FLANNELS

I have a few button-down flannel shirts, including a wool one. Sometimes I wear a couple at a time. One nice thing about flannels is that if you start getting hot you can easily unbutton them and let some air in.

HOODED SWEATSHIRTS

Plain black hooded sweatshirts are my first line of defense. I've run out of time and inclination in my life for patching up hoodies that don't need patching. I know, I know! Where's my punk rock pride? But these days I'd rather build musical instruments or garden or play with my kids than spend time patching things that don't need patched.

When it first starts getting cold, I put on a hoody. When it gets colder I add flannel under it. Then a long sleeve shirt. When I didn't have a winter coat at all I used to wear two hooded sweatshirts and a flannel as my winter coat.

The hood is not a good hat replacement. When you're riding your bike it acts like the hood scoop on a hot rod, directing air down into your coat. It's not a great way to stay warm. Not only that, the sides of the hood tend to block your peripheral vision. I don't think that's safe. So sure, use it in an emergency when things get colder quicker than you anticipated, but avoid it as your standard hat.

WINTER COAT

I've been riding year-round for about 10 years, and for many of those years I didn't even own a winter coat. I always made due with a lot of thin layers. With layers, the warmth doesn't only come from the thickness of the materials but from the air trapped between each layer that prevents cold from transferring to your body.

A couple years ago I picked up a winter coat on clearance. When it starts getting really cold it's super nice to be able to throw on one thick layer. The one downfall is that if it warms up a lot, I end up sweating like the dickens because I don't have layers to remove.

WOOL SOCKS

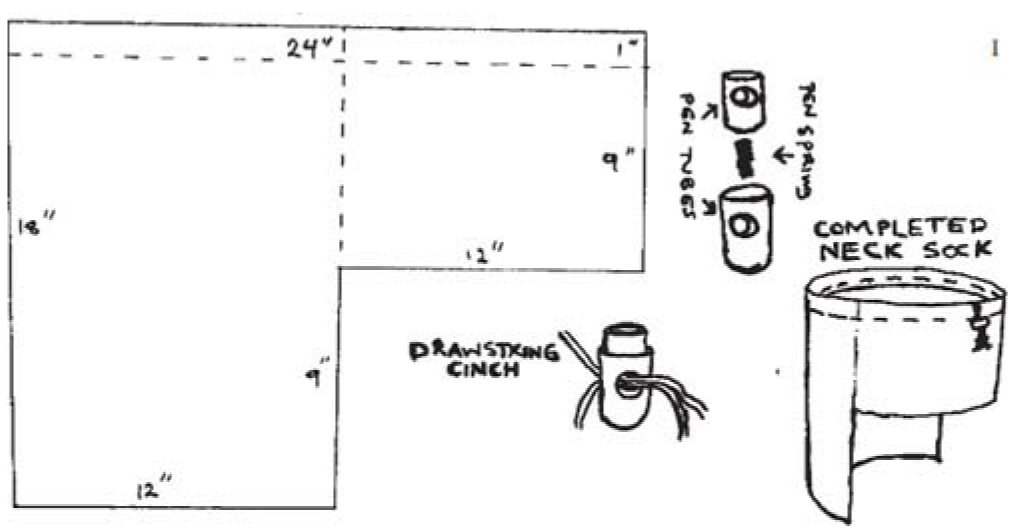
I wear military boots year-round. Not much changes from summer to winter unless it starts getting really cold. Then I put on some wool socks. If it's extremely cold I'll put them on over my regular socks. The problem with

adding too many layers in your boots or shoes, though, is that if it gets too tight it slows your circulation and makes your feet even colder.

SCARVES

I swear by neck socks, cylindrical scarves that you pull over your head. They often have a draw string to hold them in place. They can be a bit hard to breathe through, especially when you're really biking hard, but you can remedy this with a kerchief. Tie the kerchief around your nose and mouth (bandit style!) and then pull the scarf up over your chin leaving your mouth and nose covered by just the kerchief. The kerchief will be easy to breath through and if your need more warmth you can pull the scarf up over it.

Spare kerchiefs are often handy. I always have one around my neck, one in my back pocket, and usually one or two in my bag. I use them to keep my face, ears, and neck warm and to keep wind out of my ears.



If you don't have a scarf handy, grab an old t-shirt out of the rag bag, and cut a strip about five or six inches wide so that it is still a loop. The loop should wrap around your head twice, with one loop over your mouth and nose and the other around the top of your head. It makes a heck of a difference for a piece of thin rag!

MAKE A NECK SOCK

My store-bought one, which was little more than a fleece tube with a drawstring, was always coming untucked from my coat and letting the cold air in. So I decided to make one with a long front that would stay tucked in. Cut a piece of fleece to the dimensions marked out below. Allow an extra inch or two so it's not too tight after fitting around your hair. One nice thing about fleece is that you don't need seams on all the edges, because it doesn't fray. I chose 18" long because that's how wide my material was.

After cutting it out, fold down the top inch and sew it to make a tube for the drawstring. Fold it in half and sew the edges together. Turn it inside out so the seams are on the inside and you are done.

Mine was tight enough I didn't need a drawstring, but if you want one, cut a slit in the back of the tube and run your drawstring though it. Use a shoelace.

A drawstring cinch is really handy and you buy them for about 50 cents, or can make one from pieces of an old pen. You need one tube that slips inside another and a little spring, like from a clicker pen. used plastic tubes from two different pens. Both tubes need to be closed at one end, and this can be easily done with a cigarette lighter. Warm up the plastic, and roll the end on a hard surface to push the end closed. Put the spring in the larger tube, and then push the smaller tube down on top of that. Make sure that it moves freely. Mine didn't at first, so I used a bit of sandpaper to fix that. Hold them together, making sure the spring is compressed, and drill a hole though them both.

If you don't hold everything together, the pieces will shoot everywhere. Put your drawstring through the hole and tie a knot on the end, because if you accidentally pull it all the way out, your cinch will fly apart and you'll lose all the pieces.

HATS

When you don't have a hat on, your body heat escapes through your head

and you cool off fast. So if you want to stay warm, wear a hat. Conversely, if you're starting to get too hot one quick way to cool down is to whip your hat off.

For those days when it gets really cold, a balaclava (face mask) is nice. I have one that is thin enough to still breathe through, but adds some extra warmth.

When you have long hair, especially if you have dreads, your hat tends to slide up your head and uncover your ears. I sometimes wear a headband (the kind for skiing that covers your ears) under my hair and then wear a hat too. Something I use a neck scarf as a hat. Pull it on upside down, pull all your hair out the top, and then pull it up so that the drawstring is under your ears and above your eyes. This works fine except on the very coldest days.

GLOVES

I have a habit of losing gloves. I pull them off and stick them under my arm and then forget they're there. Or they fall out of my pocket. So I buy packages of white cotton work gloves. My wife hates them, but they're really cheap and they do a good job of keeping my hands warm most of the time. A pair of cheap canvas gloves over those is good enough for all but the coldest days.

I used to use those one-size-fits-all stretch gloves. When it got to the stage where that wasn't warm enough, I'd add a pair of military surplus wool glove liners over the top of those. When it got even colder, I put knit mittens over the top of that. Most of those cost about a dollar a pair, so even with all four layers it was only about four bucks.

That's the cheap method, but multiple layers of gloves are a pain and don't always do the trick to keep your hands warm. So a few years back I bought some insulated leather gloves. I only wear them when I really need them, so they've lasted me all this time.

One thing to think about is that you want to be able to lock and unlock your bike without taking all your gloves off. Having at least one thin layer at the

bottom keeps your hands from freezing while you do this.

GLASSES/GOGGLES

If you live in extreme northern climates, there are going to be days that are extremely cold. When you ride on those days, you'll want to cover every inch of skin. That means pulling your hat down over your eyebrows, your scarf up to your lower eyelids and putting on some glasses or something so you don't freeze your eyeballs.

Safety goggles are a cheap option. You can also wear your regular glasses, or your sunglasses during the daylight. The problem with all of them is that they tend to fog up. The colder it is and the harder you breathe, the faster they fog up.

The one thing that I found that works really well are sunglass style motorcycle goggles. They have soft foam around the outside of the lenses that rests against your face. There are breaks in the foam which allow a little bit of air to flow to carry away the moisture behind the glasses. Ski goggles would probably work the same way.

If you're having trouble with your glasses fogging up, try directing your breath down. Pulling your glasses up when you have to stop can also help. I heard that licking your lenses before you head out can work, but I've never tried that.

All that said, glasses aren't an absolute necessity. You're not climbing Mount Everest, and the chances of your eyeballs freezing are probably pretty minimal. Glasses can make things more comfortable for you, but if you can't keep them from fogging up, they're probably not worth it.

BAGGIES

When I was a kid we always used plastic bread bags inside our boots. The boots get wet, but your feet stay dry. You can also use a baggie to keep your wallet dry.

COOLING DOWN

Okay, I've pretty much covered all the ways for keeping warm, but almost as important as keeping warm is keeping cool. Because if you let yourself get too warm, you'll start sweating and then that sweat will cool you down.

If you start getting too warm uncover your head. Some other areas are your neck, your wrists, the inside of your elbows, armpits, and behind your knees. Basically anywhere that your blood vessels are close to the surface. Take off your scarf and gloves, unzip your coat, and slide your sleeves up to uncover your wrists. That should cool you down in a hurry.

WINTERIZING YOUR BICYCLE

Winters in Minnesota are very hard on bikes. Snow gets stuck to your bike, and then melts ever so slowly with a little bit of warmth to make your bike rust really good. Then there's all the salt and grime from the street which the snow leaves behind on your bike when it melts.

Winter is especially rough on moving parts. Chains take it hardest. They get rusty and stiff and give you all sorts of trouble. After the chain, the bottom brackets and pedals get it the worst.

Sometimes I use the same bike from one winter to the next. Other times I'll find a cheap bike at the thrift store or a discarded bike from someone's garbage to use as a winter bike. Winter is a great time for thrift store bikes! They're still coming in but they're not going out, so they have to drop the prices way down. I usually look for a ten-speed style bike.

Some people will try to tell you that you should have a "wide footprint" for winter riding. What they mean is that you should get the widest tire possible and keep the pressure low, so you can "float" on the snow.

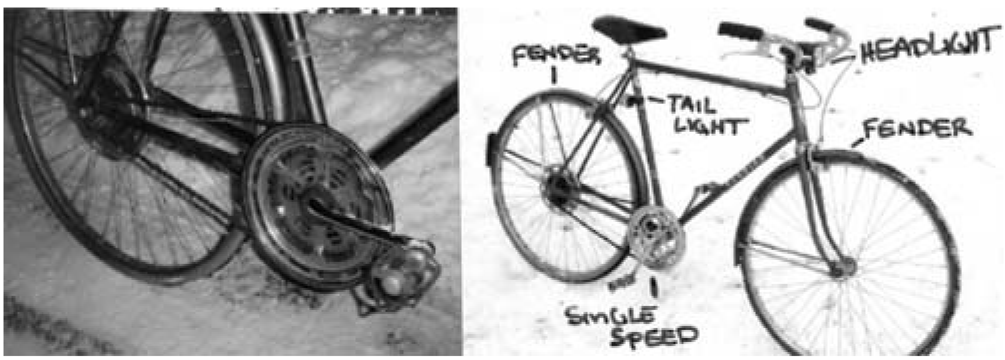
The more tire you have, the more drag you have. This doesn't only happen in the winter; it's always the case. A mountain bike with fat tires will take more work to ride than a road bike with nice thin tires.

In the snow, the drag gets even worse. Instead of floating, you're going to have push through more snow, which is going to get caught in your tires and rub against your forks and fenders. Thinner wheels on the other hand cut right through the snow and slush, slicing through it rather than trying to push it out of the way. You don't have the drag, and thin tires pick up almost no

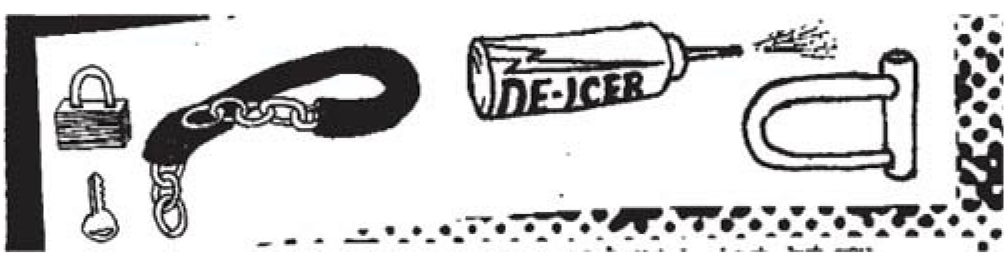
snow at all!

Wide tires do come in handy if you often have icy roads or snowpack to deal with. One option for these conditions is to get a studded wheel for your bike. These wheels have little metal studs sticking out of them to “grab” the ice.

You can make studded tires yourself but it’s rather time consuming. You get the sheet metal screws with the little hex head and screw them into the tread of your tire. The sharp corners of the screws will give you a lot of extra traction. You’ll want short screws so they don’t stick through and pop your tube (you can add an extra strip of tube just to be sure).



I give my bike a tune-up before it gets cold so I will hopefully get through the winter without having to do another. This involves cleaning and greasing the bottom bracket and the wheel hubs. I also make sure the chain is in good shape and well-oiled. And, of course, I make sure that the brakes work.



One of the most important things I do is convert the bike to single speed (see earlier instructions). The simplest way to do this is by shortening up the chain so that it only fits one set of gears. Even if your chain looks like it’s made out

of rust, it'll keep on running around those sprockets. This will save you the trouble of slipping gears and hopped chains.

One thing to seriously consider for your winter bike is fenders. When it's raining you can get much wetter from water on the pavement than from the water coming from the sky. Your tires collect water from the road in the treads and then flick it all back up on you. A set of fenders will keep you much more dry. The longer the fender, the more water, slush, and road grime it will keep off of you and your bike.

You'll also want lights for winter riding. It gets darker earlier and stays darker later, so you can end up doing a lot of commuting in the dark. The idea isn't so much to light your path but to have enough light so that drivers know you're there and don't pull in front of you (or into you). The red rear light is the most important because you can't see what's coming up behind you. Even if you have a headlight, watch out for people pulling out from side streets or making left turns. Always assume they don't see you, especially at night.

Reflectors can also be helpful but they're not foolproof. If the angle of light isn't right, they don't work.

Locks are worth thinking about. A U-lock makes it easy to lock and unlock your bike. It also means no fumbling around with a cable lock when it's -20 degrees. Always face the keyhole towards the ground so that moisture from rain and snow doesn't go down into the lock and freeze. Some water and grime will get in there, though, so put some oil in your lock on occasion. I carry a can of lock de-icer in my bag but a lighter will usually work in a pinch.

BAD, BAD DAYS

Okay, so after all that, what if one day you can't do it? What if it's too darn cold and you can't bring yourself to get on that bicycle?

Then you revert to whatever you used to do before you started winter riding.

There was one day this last year that I was coming home late, and I had gotten a flat tire, and I was cold, and I wanted to be home. That day, I stood on the side of the road with about a buck's worth of change in my pocket waiting for the bus. When the bus showed up, I gave him my sob story about getting a flat and not having the full fare, so he let me ride anyway.

But when it boils down to it, I could have walked the six miles home. It takes a while, but I've done it before. If you're going to be biking in the winter, you're obviously already tougher than most. Walking home in a snowstorm might be even faster than driving.

There are usually other options besides trekking. If your city has a decent transit system, make sure you know how to use it to get home in case you need to. Then there are taxis. And there's always the friends and family plan. If you can't make it home on your bike, plan to call your friends and family begging for a ride.

In some cities, there are programs that guarantee you a ride home if you have an emergency and have to get home right away, or if your bike breaks down or something like that. You take a bus or a taxi home and the program reimburses you.

Get to know the bike shops along your commute so you can drop in if you have bike trouble. It's a good idea to always have some basic tools on you (adjustable wrench, chain tool, small pump, a tube and/or patch kit) so you can do small repairs on the spot.

The last thing is: don't not give up too soon.

When you start biking in cold weather it will seem impossible. You'll be cold and uncomfortable. You won't want to continue. I go through it every year. When it first starts getting cold, I don't want to brave it—I want to stay inside. Then I get used to it and it's not so bad.

When winter commuting, give it a couple weeks. Don’t throw in the towel after a few days. Give it a chance, and if you can’t handle it, I won’t hold it against you.

IMPROVISED RIM STRIPS

You can make a rim strip from an old tube! While building the bed frame trailer, I noticed that neither of the wheels I had in the garage had rim strips (the rubber or fabric around the rim that protects the spokes from puncturing the tube). This is an incredibly simple, cheap and fast way to make a rim strip.

Grab a tube that is the same size or larger than the wheel. Using scissors or a sharp knife, cut off the valve stem. Pick one of the little ridges along the length of the tube and cut along that for the entire length of the tube. Figure out how wide your rim strip needs to be and cut a strip of rubber that wide.

Wrap the strip around the rim, making sure there are no twists. It should be tight but not stretched. Cut off the extra so the ends meet with no overlap. Remove the strip from the rim. Bring the ends together and overlap them about an inch so it fits nice and tight.

Wrap a piece of duct tape around it once. Fold the strip in one spot and cut a small half circle, so that when you open it up you’ll have a round hole. This is where your valve stem will go through. Put it on your rim, making sure the valve stem holes line up and there are no twists. Voila!

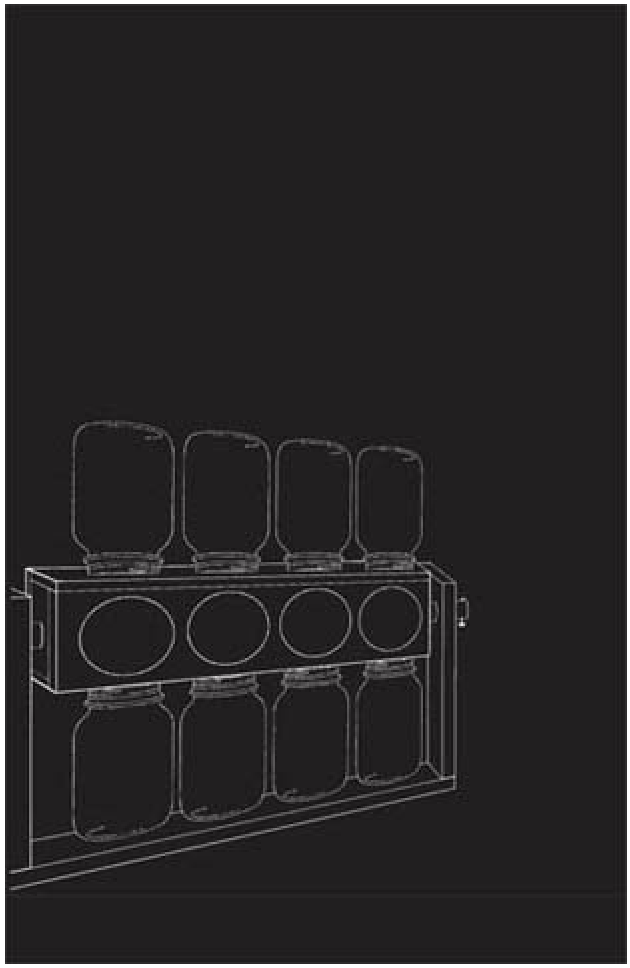
Cut a strip from an old tube

Cut to length

Glue ends together

Cut hole for valve stem

HOME & GARAGE



BUYING A HOUSE

More punks and radicals are buying houses and I have mixed feelings about it. We're getting out of the rent trap and into the debt trap, but that doesn't have to last forever. It lends permanence to our culture but can be a step towards normalcy.

Once you get a piece of the American dream, you are tempted to try for more. When passions wane, or constant action starts to wear you thin, it's easy to go from owning a house for radical reasons to owning a house.

Obviously, I think buying a house is a good thing because I did. The number one benefit is getting out of the rent trap. Rent ends up being about a third of your income. When you buy a house, you're getting something for your money. You're no longer buying a house for your landlord. You get more for your money than a house—freedom.

With your own house, you have the freedom to have a garden. You can have a compost pile. You can make changes. If you want an extra room, you put one in the basement. If you want to set up rain barrels, have pets, keep a worm bin in your kitchen, install a graywater system, change electrical or plumbing fixtures to make things more efficient, install solar panels or whatever, and there's nobody to stop you!

When stuff breaks, you don't have to wait for an unreliable landlord to fix it. You can take the initiative to fix it. If your sink is plugged up, there's nobody to blame but yourself, and if it gets fixed, you know who to praise. Once you start doing stuff around the house, it gives you a lot of confidence and it feels good to do it yourself.

When we considered buying a house, it was because ours was being sold to a neighbor who wanted to cut it up into tiny little sections and rent it out by the room. The owner had a lot of bad tenants (including our previous upstairs

neighbor) and was fed up with renting, so she offered to sell the place to the guy who owned the house next door. We asked how much she was selling it for and she told us it was $40,000. We offered $45,000. We said we'd do a contract for deed and pay her $10,000 down and $500 a month. We figured we'd continue to rent out half of the house and make our payments that way.

A contract for deed is a method of financing in which the title remains in the seller's name until the buyer has paid the full purchase price. The previous owner finances your mortgage. This is a good way to buy a house if you have no credit and no other options, but it has its disadvantages.

The owner of the house sets up the rules. A late payment can sometimes mean that you forfeit the house, whereas with a mortgage company it would only mean a $20 late fee and a strike against your credit record.

A good way to avoid this would be to do a lump sum at the end of the contract, as opposed to at the beginning. This gives the owner incentive to be lenient and also gives you time to save up the money you'll need for the balloon payment.

We looked for a $10,000 loan but couldn't get a loan for a down payment on a house because there is no collateral. For a normal mortgage, the house is collateral. If you don't pay the mortgage, you lose the house. So we started looking to get a loan for $45,000 instead.

I hadn't been at my job for a year but had to show two years worth of employment in the same line of work. We hadn't even had a residence for two years and it was seemingly impossible for us to get a loan.

We ended up buying ourselves some time. While looking for the loan, our landlady decided not to sell the house. She had two good tenants and we weren't going to be able to get a loan anytime soon. Then the house started showing its dark side: electrical problems, plumbing problems, lead paint, etc.

Those problems pushed us to find a new place to live.

The housing market in Minneapolis was tight. We'd call on a house, and it would already be sold. We'd go see a place, go home to think about it, and it would be sold. We realized that if we wanted a house, we'd have to decide on the spot whether or not we wanted the house.

In all the houses that we looked at, we had never found one that we entirely liked—there was always something that turned us off. I had resigned myself to the fact that we would not find the perfect house, but Rachael knew what she wanted and was pretty determined to get it during the first year we were looking. Then we started putting bids on houses that were pretty much what we wanted but not perfect.

The realty business is crooked and dishonest. We would put a bid on the house and the seller's realtor would sell it to one of his customers before our bid was in—and get double commission. Other times the seller's realtor would sell it to one of his cohorts, probably so he could turn around and sell it again for more money. This is called flipping. Realtors would conveniently be out of town at crucial times.

Realtors weren't interested in us because we were looking at inexpensive houses. We ended up going through three realtors before we decided that if we wanted to look at a house, we would call the seller's realtor.

Rachael found the Minneapolis Listing Service (MLS), where realtors get their information. The houses are listed before they're in the paper and often before there is a sign in the yard.

When you start looking for a house, one of the first things to do is to get pre-approved for a loan. You bring in recent check stubs, two years of tax returns and W2's, bank statements from the past six months, and proof that you pay your bills in a timely fashion. If you have credit, you don't have to worry about the latter. If you don't have credit, you'll need to bring in 3- 6 months worth of utility bills, showing that you pay on time, every time. They look over all this information and tell you how much you can get a loan for.

So the first thing you need to do is make every effort to pay your bills on time. A good way to do this is to pay right when you get the bill. It may be tight the first month you do it, but after that you'll always have about a month's leeway if you are ever really strapped. You can put off a bill or two until it's due, and then pay it as soon as possible the next month. The second thing you need to do is save those bills and every other financial record you have: paycheck stubs, bank statements, bills, and tax returns. You can request new copies of some things. Most banks will print off your records for free and you can request your tax returns from the IRS, but most bills you cannot replace, so don't lose them!

Most loan companies don't want to deal with utility bills. They want a credit history. They'll check your credit history, and when they find that you don't have one, then they'll start asking for bills and landlords' phone numbers and the like.

The way around this is to get some credit history. This is really quite easy: if you have a mailbox, you know that every company out there wants to give you a credit card. I suggest you fill out a couple applications and get at least two. I think that people should learn to live within their means and not put themselves in debt. Also, I'm totally against usury.

Here's what we did. We needed a new car. Ours wasn't doing so hot, so we found a minivan that we liked. We got a loan for it. We planned to pay it off quickly and avoid the interest, but the loan officer assured us that if we were trying to establish credit, it would be better to make the monthly payments.

Otherwise, it doesn't show that you can steadily make payments on time, which is important on a 30-year loan (since you probably won't end up paying it all off after only a couple months). So we made our monthly payments.

Then we got a Target card, which pretty much anyone can get. They may give you a $50 spending limit but that's plenty. We bought stuff we needed, only spent what we could afford, and we paid the entire balance when the bill arrived, while never paying any interest.

We bought a vacuum cleaner on credit at a department store by applying on the spot. When the card came, we cut it up. When the bill came, we paid it off. Now we had a credit history with three companies. They usually want two credit references, so we had more than enough to show we were responsible.

That would explain why the amount we were pre-approved for jumped when we started seriously looking for houses. It doesn't explain why that amount jumped every few weeks when we couldn't find a house for that amount.

Here's another secret about loan/credit companies: they don't care how much you can afford. Your rent/mortgage payment shouldn't be more than one-third your income. That's the standard that loan companies are supposed to follow. Somehow, they twist the numbers and by the time we bought a house, we were pre-approved for about $115,000 (which was way more than we could afford). Figure out how much you can afford and be realistic. You cannot eat ramen noodles and plain rice for 30 years. You can probably tighten your belt a bit to come up with a down payment, but don't plan on staying that tight forever.

If you can afford $500 a month, figure out what your limit is for a loan. If your loan officer tells you that you can afford an $80,000 loan then ask what the payments would be on that. If it's more than $500, ask what the payments would be on a $70,000 or $60,000. There are complicated formulas and websites to figure this out, but it's probably best to ask your loan officer because they usually figure in insurance, property tax escrows and the like. Make sure they're figuring that stuff in.

Make it clear to your realtor that you're only looking for houses that are within your range, as they'll try to foist more expensive ones on you. We found it best not to deal with a buyer's realtor at all. Rachael and I had decided right from the start that we wanted a house that was big enough to have people living with us. We were interested in living in community and it would help us out for making payments on the house. But we made sure that we could afford the house we bought, even if we didn't have anybody living with us.

Rachael found our house on the MLS the day it went on the market. She found out who the selling agent was and called him to look at the house. We looked at the house and it was exactly what we'd been looking for. We decided right then to put a bid on it.

We made an appointment and came back two days later to fill out the paperwork. We really didn't want to lose the house, so we decided to bid $10,000 more than the asking price of $79,500. We asked that the seller pay $3,000 towards closing costs. Before the house made it to the paper or had a sign in the yard, we already had agreed to buy it.

When selling a house in Minneapolis, a Truth in Housing report must be done. You pay a city inspector to look at your house and fill out a worksheet about what is wrong with the house. These have to be fixed before the house can be sold. The seller should provide you with a copy of the Truth In Housing report when you look at the house. Not all Truth in Housing reports

are the same. Some are very detailed and thorough, while others neglect very obvious problems. One house had five layers of shingles on the roof when the most you should ever have is two. This wasn't mentioned in the report. The reports overlooked such obvious things that we felt the inspectors must have been paid off.

It's better to know what problems to look for and not rely too heavily on someone's report. You can hire your own inspector to look at a house, but that is more money and one more step to fit in when time is already of the essence.

The first thing to look for in a house is whether it fits your needs. Know what you want before you start looking. There was only one bathroom and a toilet in the basement, which probably wouldn't be enough for four or more adults and a couple kids, but that was something that could be remedied. We converted the toilet in the basement to a 3/4 bath. If you find a house that you think fits the bill, the next thing to look at is the structure.

Take a good look at the foundation. This could be the most important part of the inspection, as the foundation supports the house. Walk around the outside first, paying attention to cracks and patched cracks. Go into the basement and take a good look around. Look for cracks or water damage. Damp spots on the walls do not necessarily mean a leak; it could be condensation. Check the doors and floors. Sagging floors or crooked doorways could mean that an inordinate amount of settling is going on. Every house settles. In our house it's pretty minimal: some cracks in the walls, a couple doorways that are a bit askew and that's about it. In the duplex we lived in, it led to severely buckled walls, sagging floors and ceilings, and doors that wouldn't close.

Take a look at the roof. A quick visual inspection should let you know whether it's in good shape or not. Keep an eye out for curled or missing shingles, or moss, which indicate you may need a new roof soon. Try to find

out from the current owners how old the shingles are. Shingles should last at least 15 years, and as much as 25. Take a look in the attic or upper level for water damage. While you're outside looking at the foundation and roof, take a look at the siding. Peeling paint, split siding, or excessive rusting of nails could be indicative of a moisture problem. Look at the windows and doors. Is there good caulking around them? Do they close tightly?

Make sure heaters, water heaters, and electrical work. Most houses you look at will still have people living there. Turn on the lights, turn on a TV or radio, see if the fridge is cold, turn on the hot water and make sure it runs hot. Some people suggest checking every outlet in the house. Turn on all the faucets and make sure they work and drain. Ask the owners what the utility bills are like. Find out if the appliances come with the house. If they don't, that's a sizeable chunk of money you'll have to drop when you're probably already tight.

Realize that some problems can be corrected. A high electric or gas bill could mean that the windows are leaking, a problem that may easily be repaired with a little caulking. It could mean that some of the appliances are very old and use a lot of electricity. Missing appliances may be able to be found for cheap or free. A bad roof can be fixed or replaced. Windows or doors can be fixed or replaced. Leaky faucets, running toilets, slow drains are all things that can probably be fixed pretty easily. Peeling paint is pretty simple to fix, a bit time consuming.

Keep in mind that interior walls painted before 1972 and exteriors painted before 1978 contain significant amounts of lead (a health hazard, especially to kids and pregnant women). It's not only a problem of kids eating paint chips; it's a problem of paint dust (common around windows and doors) that everyone breathes in.

In our house, there were a few problems. There was cracking and chipping paint that had to be repaired. We painted the entire main level but upstairs we only painted primer over the cracks. To this day there are white stripes and

patches over the lime green paint.

We put a cleanout plug in the downstairs drain and fixed the loose railing out front. We got the inoperative sink in the upstairs kitchenette running, fixed the leaky toilet in the basement, and repaired the running toilet in the main bathroom.

If you've worked on a house, a lot of jobs sound a lot easier than they are. Painting takes much longer than you expect. Don't do a half-assed job or you'll regret it later. Fixing a leaky toilet will be a quite a daunting task when you actually get down to it and realize you know nothing about toilets, especially this antique thing in your basement!

You're not going to find the perfect house and if you do, it won't be for long. Part of owning a house is that it requires some work now and again. Minor problems can bring down the price of a house, so don't look on them with too much scorn. Figure out how much you can handle in repairs. How much money can you afford? How much time can you afford? If you can afford the time, it may be worth your while to buy a house in need of more repairs.

Realize that about half the price of repairs is labor, so if you and your friends or future housemates can supply the labor, you can save a lot of money. Heed the warning from earlier: some projects can be more than you bargain for. Although it's not necessary, it's helpful if you or someone you know has some experience in the kind of repairs you're going to do.

Decide how much you're willing to pay for the house. Depending on the market, you may decide to bid more or less than the asking price of the house. It all depends on what you can afford, how badly you want the house, and how tight the housing market is in your area. As a general rule, you'll want to include a contingency clause which would state something like "this offer is subject to the buyer's obtaining financing and appraised value being equal to or greater than purchase price." It is also a wise idea to make the purchase

agreement contingent upon a satisfactory inspection. Left as vaguely as possible, this could mean nothing more than another inspection by you and is basically an easy out should you decide not to buy the house.

Another possible contigency to add is that the seller pay an amount toward closing costs, escrows, and points. This is something that can only be done with an FHA loan, which I'll explain later. Other things can be addressed on the purchase offer as well. You could request that appliances be included with the house or specific repairs be made. We made an agreement with the seller stating that we could have whatever was left in the house, provided we disposed of the two extra refrigerators. We got a couple beds, a chest freezer, and some other odds and ends. Make sure any agreement you make is in writing.

We got our loan through FHA (Federal Housing Administration) in return for painting the outside of the house and fixing the molding in a couple windows. However, this was extended, as it was winter. We had until June 1st to have it done.

FHA was created by the Federal Government to provide affordable housing financing for qualified borrowers. FHA insures 100% of the loan, eliminating the lender's risk. The borrower pays an upfront insurance premium that is approximately 1.5% of the loan amount. This money can be financed directly in the loan amount. The borrower also pays a monthly premium of .5% of the loan amount divided by 12 months. FHA requires down payment of 3%. This money can be a gift. No reserves are required. Closing costs can be financed in the loan amount.

Borrowers must provide proof of sufficient income to show ability to pay the mortgage. FHA guidelines are more relaxed, such as; a bankruptcy that was discharged at least two years ago, the use of alternative credit (utilities, cable TV, auto or medical insurance premiums, child care, school tuition, furniture or appliance store accounts) in lieu of traditional credit, and higher debt to

income ratios. FHA interest rates are extremely competitive with conventional rates.

Fannie Mae loans are conventional loans made at the risk of the lender without the benefit of any government guarantee or government insurance. A conventional loan with a loan-to-value (LTV) ratio of greater than 80% requires primary mortgage insurance, which can be paid monthly. The borrower must have 5% of his/her own funds for the down payment and two months' reserves on deposit. Closing costs must be paid by the borrower.

The requirements of a conventional loan applicant include excellent credit, job stability with sufficient income, a sizable down payment, and low debt-to-income ratios. Borrowers who meet Fannie Mae guidelines are rewarded with an interest rate only slightly lower than an FHA interest rate. (www.fhatoday.com)

Another option to look into is HUD (U.S. Department of Housing and Urban Development) houses. Maybe things have changed since HUD was started or maybe people's ideas of HUD have always been skewed. Although HUD homes are supposed to be affordable for low- and moderate-income families, buying a house in disrepair often costs similar to buying a house in good repair.

Most HUD houses need some repair. HUD acquires houses when someone with a HUD-insured mortgage can't meet the payments. The lender forecloses on the home and HUD pays off the house and takes ownership. Someone who can't make payments on the mortgage probably has not been able to afford upkeep on the house, either. Sometimes people will pretty much trash a house before leaving, since they know they're going to lose it. These will be your responsibility if you buy a HUD house.

Even though HUD takes no responsibility and does not fix the problem, they will often write an allowance for repair into the price of the house. So the list

price of the house may be $70,000 and you would get a loan for that amount, but get $20,000 towards necessary repairs. This is easier than buying a $50,000 house in need of repair and doing the repairs yourself, since you don't have to pay the $20,000 out of pocket all at once.

Even though they give you an allowance for repair, you have to pay for it out of your own pocket at first. Say the foundation needs repair to the tune of $5,000. You have to pay that $5,000 out of your own pocket, then an inspector comes to make sure the repair is up to HUD standards, and then you will be reimbursed. One big benefit of HUD homes in a tight housing market is that you don't have to fight with investors trying to buy the same property. The initial offering on HUD homes is restricted to owner occupants, and only if the house is not sold during the initial offering then the house is available to investors.

I tried to do some research on multiple party loans but I was having a hard time coming up with information. I know it's possible, but I also know how community houses work: unless someone takes the initiative to make sure bills are paid on time and repairs are taken care of, they won't be. If one person or a couple own the house then they are most likely going to take responsibility for it, whereas in community situations it seems that it's more likely that problems will arise.

BED FRAME SHELF

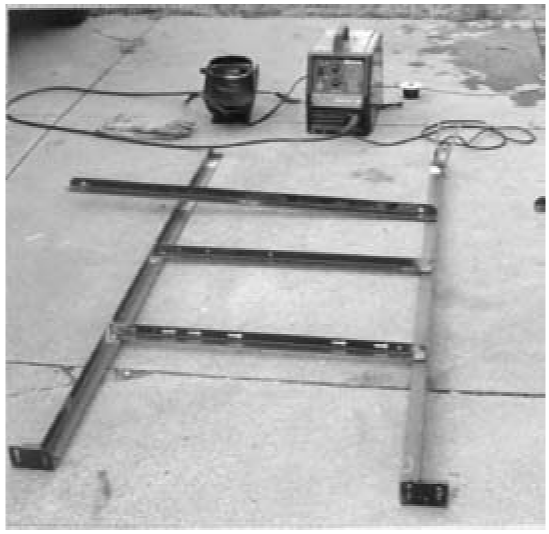
I had a bunch of motorcycle parts I needed to find a place for in my garage. I was planning to build a shelf from some of the scrap metal in my garage, but got lazy and tried a store-bought one. It was supposed to hold 2,500 pounds but it was a flimsy piece of crap, so I took it back and built a serious shelf.

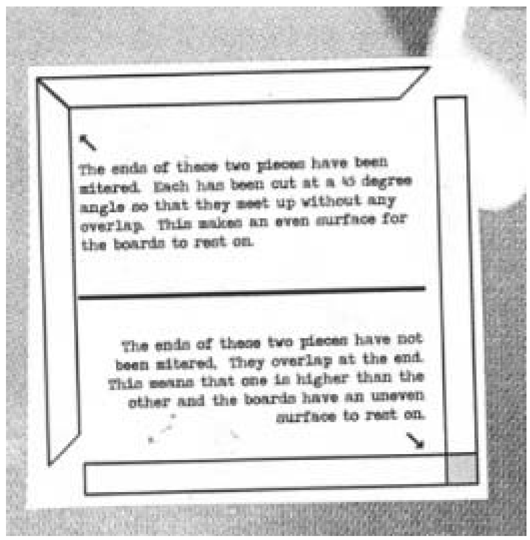
My original idea was to use some pipes as the upright legs and bed frames as the cross members, but I came up with something better. I realized that the round legs would be hard to work with and that I would be better off building the whole thing out of bed frames.

The benefit of using bed frames is that they're free and you're using someone's trash. The downside to bed frames is prep work. They have legs and connectors and folding bits, and it all has to come off or come apart. So I spent a decent amount of time that first day grinding off rivets and knocking pieces apart.

I started laying out bed frames and measuring them. I had four identical uprights, four identical cross members for the long side and a piece that, cut in half, would make two good cross members for the short side.

Then came more measuring, along with figuring out where each shelf should go and how many I would need. My shelf was built for my needs. I build it short enough to fit in the garage. I spaced the shelves so that I could fit a 30 gallon tub and a couple 5 gallon buckets on the bottom, and above that the shelves were spaced to fit milk crates that I use for storage. It wouldn't make much sense for you to use my measurements if you need a shelf for holding paper boxes, or if you're building a book shelf. Take your own measurements, figure out what you need and built it to suit.





Take some time to plan out what you're going to do. Going over different options on paper can be really helpful. Often times you can make better use of what you have or create less waste or both. Seeing something on paper will bring out things you didn't think of before. My original plan would have left pieces of angle iron 12" to 18" long unused. By laying out my piece differently, I was able to reduce the waste to four ½" pieces.

First, lay out a pair of uprights with two identical cross members in between. Another one across the bottom will help keep everything parallel and lined up. If you want, you can grind off the paint where the pieces come together. This makes for a cleaner weld but isn't entirely necessary. Although I welded my shelf's frame together, it could have been assembled with bolts. In that case, drill holes and use bolts with nuts and lockrings. Then add some diagonal bracing on the back of the shelf to keep it from swaying. Weld or bolt the crossmembers to the uprights.

You should plan to miter the ends of the crossmembers. I didn't plan properly so I had to do some tricky cutting on a couple pieces I'd already welded. A miter is when an angle is cut where pieces meet so that they line up flush (think of the corner of a picture frame). Luckily, I realized this after only four cross members so I was able to miter the rest of the pieces before I welded them.

Once you have your first two crossmembers in, you can add others where you need them. Once the first section is done, make another identical to it.

Now you've got two sides of the shelf and all you have to do is connect them.

Use some C-clamps or vise grips to attach cross members between your two sides. Make sure that the tops of the crossmembers are even with each other and that everything is kept parallel. Doing two at a time works well, especially if you don't have a lot of clamps. Weld or bolt everything together.

When you're done welding or bolting everything together, check all of the connections and make sure you haven't missed anything. When I was done, I tested the strength by climbing it. Especially after monkeying around with that store bought shelf, I was impressed. It took a little longer to build, but it was super sturdy and had no sway. I trust it to hold whatever I put on it. I expect it to last forever, and that's worth putting some extra time into.

The last step of this is to cut some plywood fit your shelf. Again, plan ahead before you make your cuts. By mapping out my cuts ahead of time, I was able to get all my shelves out of one piece of plywood.

BUCKET MOUSE TRAP

When the mice moved into the basement we weren't too thrilled. Had they been clean mice like the ones in my kids's books that wear overalls and draw pictures, then it would have been alright. However, these were the type that chewed everything and pooped everywhere. We tried many different kinds of mouse traps. We tried snap traps but they licked off the bait. They were smart enough to turn live traps on their side so the door couldn't close.

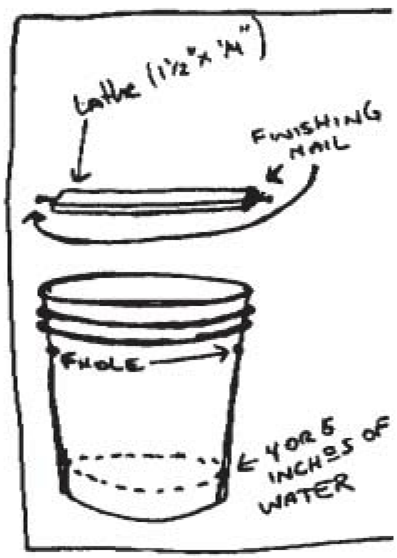
I started researching bucket traps. The idea is you entice the mouse to try to get at a treat suspended over a bucket of water. When the mouse tries to get at the treat it gets flipped over into the bucket.

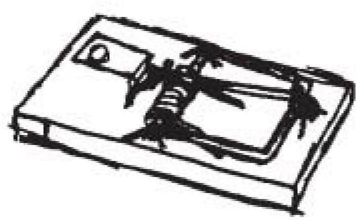
There was a bucket of lathe in the basement that I'd been using to frame pictures. I cut a piece a little smaller than the opening of the bucket and drove a finishing nail in each end.

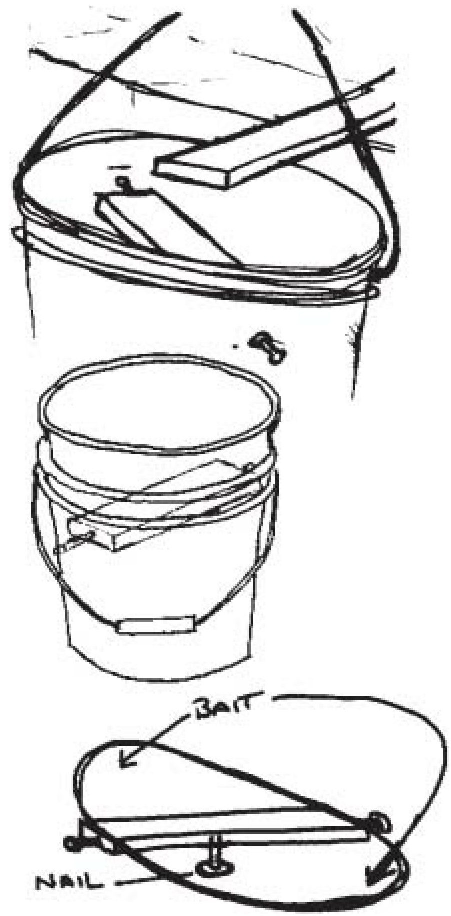
Finishing nails have small heads, so the holes in your bucket don't need to be

very big. Put the holes several inches down so the mice have to jump.

If your mice are on the floor, you make a ramp up to the top of the bucket. My mice were in the ceiling, so I hung the bucket near the wall where the mice lived. I smeared peanut butter all over the lathe and stuck the nails through the holes in the bucket. Then I put a couple inches of water in the bottom. Using another piece of lathe, I made something like a diving board over the bucket.







1) Mouse smells peanut butter
2) Mouse jumps to get peanut butter
3) Lathe flips over and mouse falls into water
4.) Mouse swims until too tired and then drowns

It won't work without the water. A mouse can climb right out of a dry bucket. If you're looking for a humane trap, you'll have to try something else.

One benefit of this trap is that it will catch multiple mice. I've caught as many as three at one time.

Check your trap frequently to make sure you don't end up with rotting mice in there. The hooked end of a stretched out coat hanger works great to get them out of the water.

One improvement I've been planning to try (if the mice get the hang of this one) is to staple a round piece of cardboard to the lathe and put the bait on the edges of the cardboard. Because it would look more like a stable surface and the mice wouldn't be able to see the bottom of the bucket, they should be more likely to jump. A heavy nail driven into the bottom of the lathe should make the cardboard sit level, but not prevent it from flipping when a mouse jumps onto it.

BUILD A BETTER MOUSETRAP

I build live traps not to be humane but because mice are smart. Even if you glue the bait to snap traps, the mice get good at nibbling the treats right down to the glue without setting off the trap. You need to outwit them.

If you want to catch and release your mice, that's fine (so long as you don't release them near my house!) Whatever you do with them, you have to catch them first. I devised this trap for the purpose.

To build this mousetrap you'll need:
- standard wooden snap trap
- large tin can (about 30 ounces)
- two screws
- piece of ¼" hardware cloth to cover the can's opening
- two short pieces of wire
- one popsicle stick or tongue depressor

- hot glue

First, attach the tin can to the snap trap. Set the trap, then slide the wood under the can with the trigger going into the can. Screw a couple of sheet metal screws through the can and into the mousetrap (you may need to pre-drill the wood so it doesn't split).

Once you do that, you'll need to attach a piece of hardware cloth to the wire that usually snaps down and kills the mouse. The hardware cloth should be slightly larger than the opening of the can. I attached it with two small pieces of copper wire, using it like a twist tie.

Push the wire and hardware cloth down like you are going to set the trap. The wire that attaches to the trigger will no longer work correctly because it has to come through the cloth first.

See where it pokes through, and then cut one or two wires out of the way, making a couple of the little squares into a small rectangle. The slightly larger hole should be enough to make the trigger work again.

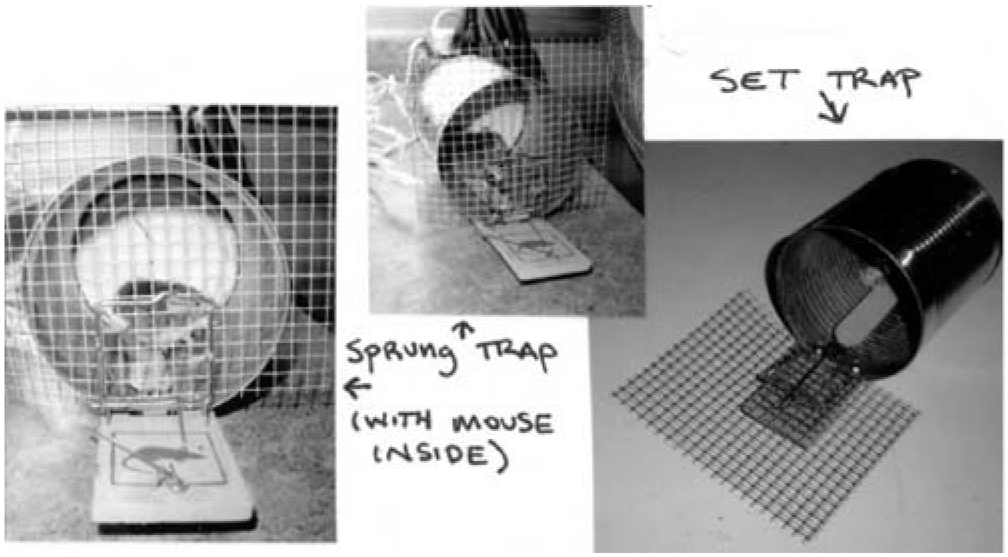
The final step is to enlarge the trigger. Cut your popsicle stick or tongue depressor in half and glue it to the metal trigger. This should almost reach to the back of the can. The longer and wider the trigger is, the more difficult it will be for the mouse to miss it.

Now make sure it works. Set the trap and then throw a nut or something into the can so that it hits the tongue depressor. If it snaps shut, you're in business! You might need to bend the corners of the hardware cloth a bit to make sure it sits tight against the can.

About anything will work for bait. I used a marshmallow rolled in sunflower seeds and placed it in the back of the can so the mouse had to go all the way in to get it.

So far I've caught two mice this way.

I have consistently had good luck with the bucket trap and the live trap. Each works better than any store-bought trap.



BUILDING WITH SALVAGED MATERIALS

Building with salvaged materials takes a little more time but can cost a lot less money. When I was young, we built everything out of salvaged lumber, including quarter pipes, launch ramps, rails, and a half pipe. We never bought wood or nails.

This was before any of us had cars to haul wood home in. We'd cruise local construction sites and vacant lots for wood. Old realty signs were made of nice thick plywood and places were always throwing out lengths of 2x4. It was only a matter of collecting them and then building. I'm still pretty amazed by it all.

I drew up my plans for a greenhouse and figured out how many lengths of lumber I'd need and in what lengths. New lumber would cost $78-103 depending on whether I built it with 2x2s or 2x4s.

One day on the way home from work I noticed a construction dumpster full

of 2x4s. It took me less than 30 minutes to pull them out and strap them to the roof of my car. It took me another 30 minutes to unload the boards, pull all the nails, and measure them.

I added up everything I brought home that day, it's about $55 worth of lumber if I bought the same pieces new—and some of these were 16' long! Plus, I'm saving those materials from going to the landfill and being wasted.

Years back, I carried a tape measure with me at all times. I always had projects in mind that I needed things for, and I didn't want to carry home a length of wood on my bicycle if it wasn't going to do the job. Nowadays, I grab whatever I can bring home and often times when it comes time to build something small, I already have the lumber around to build it.

In order to build with salvaged materials you're going to need a few things:
- a way to get the materials home
- gloves
- boots
- prybar
- hammer
- -measuring tape

One of my favorite places to look for materials is in construction dumpsters. Outside of a house, they will often have interesting stuff in them: stuff that's been removed from the house. The other day I stopped at a house that had a couple marked "TUBS" out front and ended up bringing home some tongue and groove paneling for use on a worm bin. I also got a box of nails and screws and assorted fasteners.

It's even better if you can find a dumpster at a construction site. You have to train yourself to look for them because the dumpsters at big developments can be gold mines! Some of it is thrown out because it's not perfect quality. For example, some of the 2x6s I got the other day had pretty nasty knots in them, but they'll work fine for building a raised bed garden. Some also has a twist to it, but you can even find uses for that too. Just to be clear, I'm talking about taking wood from the dumpster at a construction site, not making off with their lumber. Salvaging I will wholeheartedly promote; stealing I can't abide by.

If I see a dumpster somewhere, I'll stop long enough to take a look. If there's good stuff in there, I'll come back with a way to haul stuff. You have to work quick because the stuff on top today most likely won't be on top tomorrow, and may not be accessible. There's also the chance that it won't be there at all because:

1.) Dumpsters get emptied.
2.) Others may have the same idea as you.

When you find a promising dumpster, climb the ladder and peek in. If things look promising, look for a good place to get in and out, like somewhere that won't shift and doesn't have nails sticking up. This is where boots and gloves are important. I don't bother with steel toes and soles—I make sure I've got something thick enough to keep a nail from going through and won't get shredded.

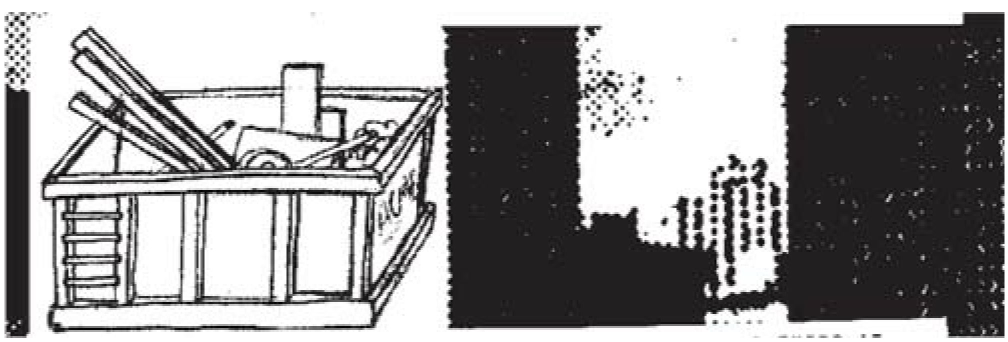
Test where you're planning to step and make sure it's sturdy. You don't want to end up skewered by a piece of conduit or something. Gloves are very handy, too. Sometimes you need to work fast before someone shows up and tells you to get lost. Without gloves, that means some serious slivers. Even a pair of cotton knit gloves is enough protect your hands from slivers.

Another good place to get lumber is from sites that are being torn down. A friend happened to be driving by an old building being torn down. He asked if he could get some wood and brought home some nice old growth hardwood, which he used for building guitars. Old buildings have a lot of

really nice old wood.

Keep an eye on the classifieds for free buildings. Someone wants to build a bigger garage, and rather than paying to have the old one torn down and removed, they'll offer to give it away if someone will haul it. They'll usually either want you to pay a mover to move the entire thing or give you a time frame to get it removed.

Once I hopped in a dumpster hoping for 8' to 10' 2x4s. I started pulling out pieces much longer. I tossed the short boards in the back of the station wagon, but I wasn't sure how I was going to get the long ones home. Fortunately, I had four short straps in the car. I stacked the long boards on top of the car and wrapped a strap around each end of the bundle and cinched them tight. Then I hooked straps around those and fastened them straight down. Luckily, that was secure; otherwise, it'll always work itself free at the most inopportune time and you'll be on the side of the road re-stacking. More importantly, it's too dangerous to people around you.



On your bicycle, insecure bundles are mostly a danger to you.

At home I got out a measuring tape, notebook and pen. As I unloaded each of the boards, I measured it and pulled any nails. I kept a tally in my notebook.

2x4” x 16’
2x4” x 14’
2x4” x 8’9”
etc.

I grew up pulling nails and it’s not too difficult. My daughter was helping me pull nails today. You can do it all with a hammer, but a prybar is a big help. When nails are driven through and bent over, I use the curved end of the prybar to straighten them back up. Then I use the hammer to knock them through. I lay the board with the nail heads down on the grass and pound the nails through the board into the dirt.

Along with growing up pulling nails, I also grew up saving those nails and using them to build other things. We didn’t have boxes of nails at our disposal, so if we were building a fort out of salvaged wood, we’d have to salvage the nails too.

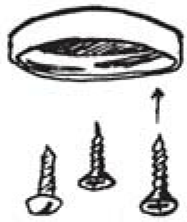
If you knock the nail most of the way through the board with the hammer, you dull the point of the nail, but end up with a pretty straight nail. Put a chunk of wood underneath the prybar to help keep the nail from bending. If you knock it through enough to grab the top with the claw hammer or prybar, you'll have a sharper tip, but the nail will have a curve to it.

You can straighten bent nails in a couple seconds. Lay them on the sidewalk with the bend up. Hold the head of the nail and use your hammer to knock the bend flat. In construction dumpsters keep an eye out for boxes or rolls of nails or screws. While working on my greenhouse today, I didn't use one new nail. I'm not sure if I'll get the whole greenhouse done with dumpstered fasteners, but I'll sure try!

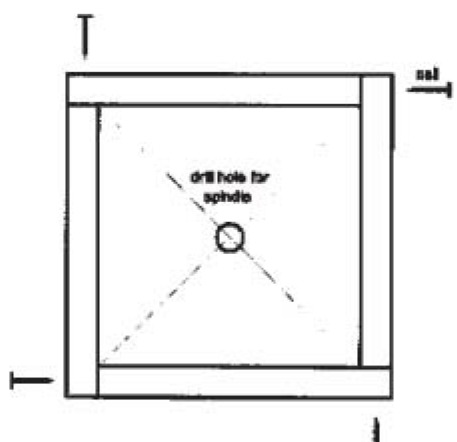
Storing salvaged materials can be tricky—especially if you're not planning to use them right away. I never seem to have enough storage room for everything. Leaving them out in the elements isn't a good idea. Any wood that is nice looking and which you want to stay that way should be kept inside, or at least off the ground and covered. Aside from looks, wood that sits out too long in the elements can start to warp and rot.

I hope it saves you some money on your future projects!

RECYCLING IS A WONDERFUL THING, BUT IT STILL TAKES ENERGY. WHAT'S EVEN BETTER IS FINDING A NEW (& PERMANENT) USE. I REMEMBER WHEN I WAS A KID, MY GRANDPA HAD A SMALL PARTS ORGANIZER MADE FROM OLD BABY FOOD JARS. HIS WERE ATTACHED TO A ROTATING THING THAT WAS ON THE WORKBENCH. I MAY TRY TO MAKE ONE OF THOSE LATER, BUT I RAN ACROSS THIS COOL IDEA AT A GARAGE SALE AND STARTED USING IT IN MY GARAGE. INSTEAD OF HAVING THE JARS TAKING UP SPACE ON YOUR WORKBENCH, YOU ATTACH THEM TO THE CEILING.



THE PROCESS IS PRETTY SELF EXPLANITARY. COLLECT A FEW CLEAN JARS WITH METAL LIDS. USING A HAMMER AND NAIL GET 2 OR 3 HOLES STARTED IN THE LID (LIKE YOU WERE GOING TO MAKE A BUG TERRARIUM) SCREW THE LIDS TO THE RAFTERS OF YOUR GARAGE. PUT SCREWS, NAILS, WASHERS OR WHATEVER IN THE JARS AND THEN SCREW THEM INTO THE LIDS.



SMALL PARTS ORGANIZER

I designed this based on a vague memory of something my grandpa Jim had when I was growing up. I used to go out in the garage and spin it around and take the jars on and off.

You need four identical lengths of board; about as wide as the caps of the jars you're going to use. I used a salvaged piece about 3.5" wide, 3/4" thick, and 4'6" long. I cut four 1' lengths and had enough left for the ends. If you have one, use a carpenter's square to keep your ends square. Once your four boards are cut, lay them out in a box shape to make a perfect square.

Measure the opening and cut two pieces of wood to fit in it (one for each end).

Using a ruler or straight edge, draw lines from corner to corner. Where the lines intersect is the center and where you'll drill your hole.

The size of your hole will depend on what you're using for a spindle. I had a chunk of ½" conduit sitting around, so I drilled 3/4" holes to fit the OUTSIDE diameter. Use anything sturdy enough to hold the weight: a long bolt, allthread, a dowel, broomstick, or something similar.

Clamping the small end pieces to something makes them easier to drill.

You can screw the whole things together now, but for extra strength and to make screwing simpler, glue it first. While the glue is wet, run your spindle through the holes to make sure they line up. Clamp with a couple C-clamps until it dries.

Once dry, put three screws in each side—one going into each end cap and one in the middle.

Now attach the jars. You want as many as you can fit on each side, but you want enough room between them for unscrewing.

Use a hammer and nail to get 2 or 3 holes started in each lid. ½” panhead screws work well. I was able to fit three 14oz salsa jars or four 8oz jars on each side.

Now make something to hold this thing. If you make one slightly less than 16” long, it could be mounted between rafters in the garage or basement. Drill holes in the rafters and slide the spindle through them with the organizer in the middle.

If that won’t work, measure from the spindle to the bottom of the longest/tallest jar and add 2” or 3”. You’ll want two boards cut to that length. Make sure the ends are very square. Clamp them together with a C-clamp so they’re lined up perfectly.

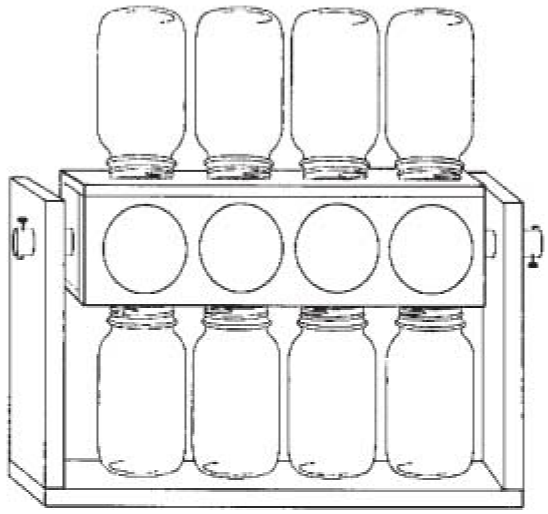
Drill a hole that is centered widthwise 1” from one end of the boards. This will be the same size as the ones you drilled in the end pieces for your spindle.

TIP: When drilling large holes through a board, don’t drill all the way through. Drill until the tip comes out the other side, then flip over and finish from the other side. This prevents the wood from splintering and chipping.

You need a board that is slightly wider than your organizer is long. I have a 12” organizer, so I added one inch plus the thickness of both boards (1.5”) and ended up with 14.5”. Like the other part, I glued this first to make drilling and screwing easier.

Lay your one board down and glue the two drilled boards to the ends. I put the spindle through the holes to make sure they lined up and left it there to hold boards in place until the glue dried.

When it’s dry, drill a couple holes on each side and drive a couple wood screws in. You’ll want countersunk ones (like sheetrock screws) with heads that are level with the surface of the wood to make mounting easier.



Come up with a way to keep the spindle in place. If you're using a bolt or allthread, a couple nuts and washers will do the trick. Since I used conduit, I had to come up with something else. I drilled a small hole through each end. Once I'd slid it through the base and organizer, I slid a finishing nail into each hold and bent it over to keep it in place.

Figure out where to put it. It can be mounted pretty much anywhere: workbench, wall, ceiling, etc.

I used all glass jars on my organizer. My grandpa used baby food jars. Although these work fine, glass will break if dropped, so plastic jars aren't a bad idea.

Use the jars to organize different types of screws, nuts, washers, wire caps, or whatever.

QUICK RELEASE BENCH MOUNT TOOLS

Ever find that you have too many bench-mounted tools and not enough bench? I bought a bench grinder for building bicycles but didn't mount it for years because it would take up more room on my bench. Well, here's a way to make a "quick release" for what would normally be bench mounted tools.

You'll need a couple sizes of square tubing. The pre-drilled kind that you see on street signs would be ideal…but I'm certainly not suggesting that you steal street signs. You can find the material thrown out or you can get it at the hardware store.

You'll need two pieces that fit together. One should slide inside the other one without a lot of play. I wouldn't go any smaller than 1" tubing and larger is safer. You need only a short length of the large one but also a few lengths of the smaller size. You'll also need some angle iron and (by now) you've figured out that I like to use bed frames.

Set the larger "diameter" tube on your workbench (or another very flat surface) and set two lengths of angle iron next to it so that they all sit flush. Use a couple C-clamps to hold the three pieces together and weld them. For non-welders, make a friend who welds. I don't know how to do this without welding.

Drill some ¼” holes through the side of the angle iron that isn’t against the square tubing. These holes will be used to mount this piece to the underside of your workbench. You’ll need to drill a hole through the angle iron and square tube. Make this as straight as possible because you’ll need to drill matching holes in your smaller diameter tubing, and you’ll be passing a bolt or cotter pin through the whole works.

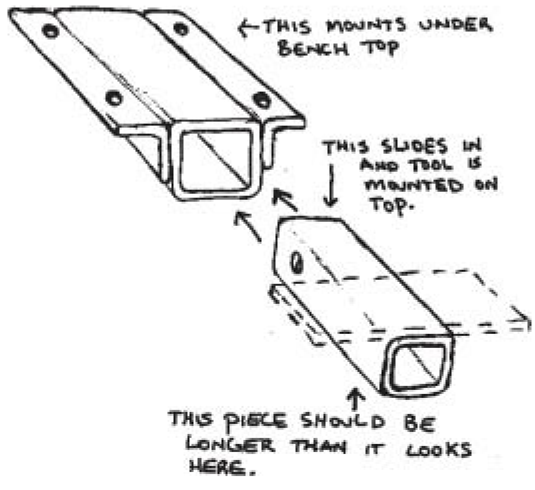
Bolt this to the underside of your workbench with the end of the tube flush with the edge of the bench. Now you slide in a section of the smaller square tubing until it meets the back of the one mounted under the table. Set your bench-mounted tool on top of that and mark where you need to cut off the tubing.

Figure out how to mount that particular tool to that piece of square tubing. You could weld a plate of metal on top or weld some angle iron to the sides. It’ll be different for every tool because every tool mounts slightly differently.

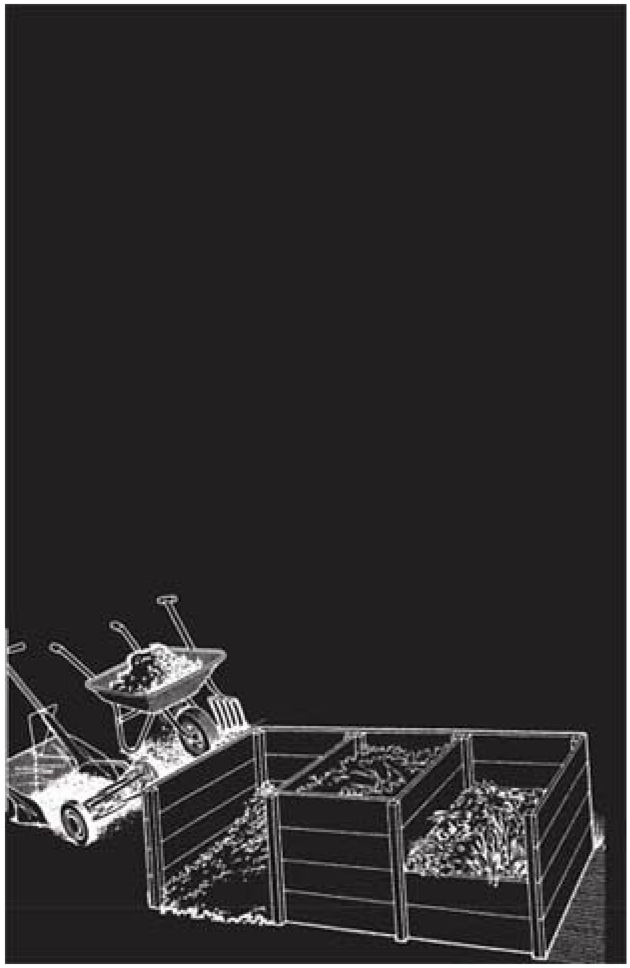
Before mounting your tool, drill a hole that matches the hole you already drilled through the other tubing. If you’ve happened to find the kind of square tubing that already has holes drilled in it, you don’t have to worry about this part.

Mount your tool to whatever kind of mounting plate you’ve come up with. Slide the small tube into the large tube mounted under your bench, and slide a bolt or a cotter pin through the holes to make it secure. Obviously, you can make as many of the small tubes as you want.

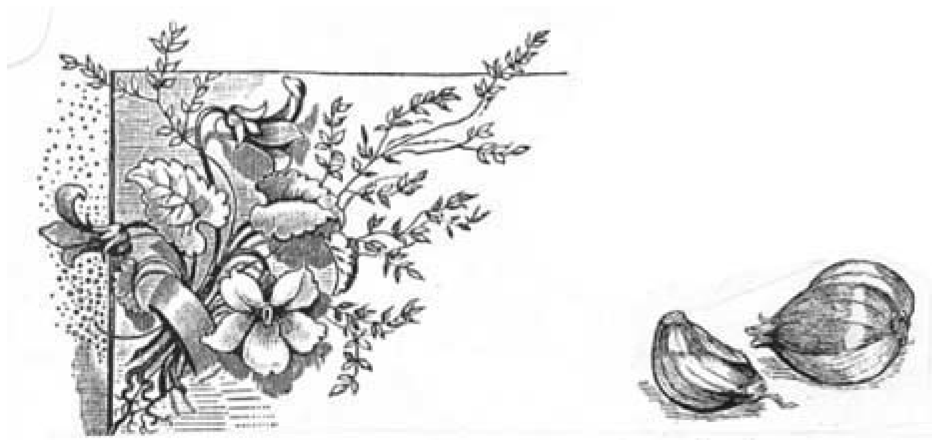
You can have one set up for your vice, your bench grinder, press, repair clamp, truing stand, bottle capper, dental drill, food processor, or whatever else you can think of. Now your bench-mounted tools can be stored under your bench instead of on top of it.


←THIS MOUNTS UNDER BENCH TOP
THIS SLIDES IN AND TOOL IS MOUNTED ON TOP.
THIS PIECE SHOULD BE LONGER THAN IT LOOKS HERE.

GARDENING



GROW YOUR OWN GARDEN



WHY I GARDEN

When I started gardening, my main thought was about self-sufficiency: growing the food that I eat. I like cutting out all the middle-men. I grow it, I eat it. The longer I garden then the more I seek that self-sufficiency.

I save the seeds, I compost the remains, I feed compost to the garden, I plant the seeds, I grow it, I eat it. If there's one place to seek out self-sufficiency, it's in our food and the way it comes to us.

You can survive without knowing how to build a bike trailer or your own musical instruments. Those are both fun but they're not requirements in order to live. Food is.

I've always dreamed of a self-sustaining community, a community that can survive without needing input from the outside world. I take steps toward that and provide for myself in ways that matter. I want to wrest control from the hands of the government, from corporations, from retailers, and take it for myself.

Another reason that I garden is that large-scale agriculture is now out of

hand. It's past the limits of ignorance and human greed and into a realm of complete insanity. A few large corporations process almost all of the food supply for most of the world. In order to get control of it, they will do whatever is necessary.

The first part of this is terminator seeds: genetically engineered (GE) seeds that produce a plant that cannot reproduce by itself. If you plant a corn seed that has been created with terminator technology, it will grow corn—but you can't plant the seeds they produce because the seeds are sterile. This prevents farmers from saving their own seed and replanting.

This technology has been outlawed but the corporations involved thought that this was a good beginning. It's about protecting their profits, but at what cost? What if those genes drifted to neighboring plants, whether they be weeds or trees or other crops? It's possible that those neighboring plants might start producing sterile seeds and that the genes could drift further, creating even more sterile plants.

Starlink GE corn was grown on only 1% of corn acreage in the U.S., but it contaminated 25% of the total corn harvest. If this story played out with terminator crops, it could mean the end of plant life and, thus, the end of humanity. Monsanto thought that it was worth the risk because farmers couldn't plant saved seed and would have to buy from them every year.

Scientists know very little about how genetic material actually functions. It's estimated that 1 in 10,000 gene transfers succeed. Genetic engineers have no control over where their inserted genes line up in the genome. It's a normal part of the process that undesirable mutants develop and have to be destroyed.

Genetic "engineering" makes this sound scientific and precise, but it's more like doing target practice with a machine gun in the dark. Shoot enough bullets and eventually you'll hit the target. As unpredictable as these processes

are, corporations are willing to risk the safety of the entire food supply in order to protect their profits. Are those the folks you want producing your food?

Governments haven't been so quick to outlaw other genetic experiments. Because the corporations involved have the money and power to make things happen, they've convinced the U.S. government (and others) to consider GE crops "substantially equivalent" to conventional crops. That means that corn is corn. It doesn't matter what processes are used to create that corn. If the end result looks like corn, no further tests need to be done because corn has been proven to be safe. These processes don't need approval, so it was easy for these corporations to inundate the food supply with GE crops.

In 1996, 2 million acres of GE crops were planted in the United States. Only 6 years later, 96 million acres had been planted with GE crops. During the same time period, demand for organic food went up 20% per year but the corporations involved flooded the market with GE crops. For example, more than 50% of cheese in the U.S. is made with Chymosin, a genetically engineered substitute for an enzyme. If you've eaten cheese recently, you've probably become part of this massive experiment. In fact, if you eat any processed food there's a very good chance that you've unwillingly become a lab rat because 60-75% of processed foods contain GE ingredients! As of 2004, over 80% of soybeans grown in the U.S. was genetically engineered, along with 70% of cotton and 35% of corn. In Canada, 60% of canola was GE.

As of 2004, the FDA had approved more than 50 GE crops, yet the majority of Americans say that they wouldn't buy GE food if it was labelled as genetically engineered. So these companies worked very hard to ensure that they are not labeled this way.

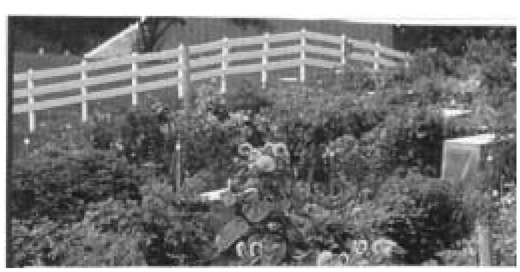
Antibiotic-resistant genes are used as markers for all genetically engineered plants. This is how companies can tell when one of their shots in the dark actually works. They dowse everything with antibiotics and if the plants live,

the gene transfer was successful. However, it has been proven that the genetically engineered material can transfer to human gut material. If those antibiotic-resistant genes are transferred to humans, antibiotics might quit working.

This is overlooked because what little testing done is usually done by the company doing the engineering. They test to obtain certain results. At this point, regulatory agencies believe that if there is no evidence of harm, that equates with safety. So if the scientists can run their tests in such a way to prove that there is no harm caused, the product is considered safe.

For example, when Monsanto was trying to bring rBGH (recombinant bovine growth hormone) to market, they contracted tests to Cornell University. However, it was a rather small test (only 30 cows) and ALL the data was transmitted directly to Monsanto. They owned the information and released only enough to make the point they wanted to make, which showed rBGH increased production of milk.

They didn't point out the numerous problems rBGH caused in the cows and claimed that the milk was exactly the same as non-GE milk, even though it contained as much as 25% more Insulin-like Growth Factor 1 (IGF-1), a messenger substance that can be found in cows and humans. The extra amount of IGF-1 can cause premature growth in infants, excessive development of mammary glands in male children, and breast cancer in women.



This was completely overlooked at first. Later when more tests were

requested, they conveniently showed exactly what they wanted: that the extra IGF-1 wouldn't cause any harmful effects. All of the tests were coming directly from Monsanto and the regulating agencies never did testing of their own.

This is one of many well-documented cases that show how the system pushes GE products through to the consumer. The whole process is set up on circular logic so that nobody can be held responsible, which is very important when you're conducting a massive experiment on the general populace. If problems arise, the corporation can say that the product was approved. The regulating agency can then claim that all testing was done by the corporation. But the corporation can turn around and say, "Yeah, but the agency accepted the test results."

Although genetic engineering is definitely one of the scariest things to happen to agriculture, it's certainly not the only reason to grow your own food. Even before genetic engineering became prevalent, conventional farming was poisoning the earth and our bodies. In conventional agriculture, one crop is grown in a field and nothing else is allowed to grow. This leaves a lot of bare soil in which applied herbicides and pesticides run off during rain. Typically, 50-70% of fertilizer dissipates and is never used by the plants. This is why virtually every stream in Illinois is contaminated with the four herbicides used in corn and soybean production. It's also why a 7,000-square-mile dead zone develops in the gulf of Mexico every spring. It's why our groundwater is being contaminated.

Of course, what ends up on the crops also ends up in us. Over one million children aged one to five ingest fifteen different pesticides a day. Six of every ten of those children eat a dose considered unsafe by the U.S. government. The EPA already rates pesticide exposure as the #3 cancer risk without taking into consideration cumulative effects or the effects of combining pesticides when determining their rates.

It doesn't affect only the consumers, it affects the farm-workers. 10,000 to 20,000 pesticide illnesses and injuries are reported every year. The symptoms can be as simple as a headache or fatigue, but can be as serious as nausea, cancer, and neurological disorders. U.S. consumers experience up to 70 daily exposures to persistent organic pollutants through their diets. Persistent organic pollutants have been linked to breast cancer and other cancers, immune system suppression, nervous system disorders, and reproductive and hormonal system damage.

If you live in the United States, you really have to take your own steps toward a more sustainable way to grow your food. Whereas places like Belgium, Germany, and the Netherlands are now making goals to convert 10-20% of their arable land to organic, the U.S. is passing laws mandating the use of ethanol to create an even greater demand for cheap corn. Of course that corn isn't actually cheap, it only appears to be cheap because it's propped up with subsidies.

Organic may cost more at the grocery store, but if the real costs of conventional agriculture were included in the price (like environmental cleanup, government subsidies, health care for farm workers, etc.), organic agriculture would be cheaper. 50% of federal taxes paid by North Dakota come back to the state as farm subsidies and Montana would have no net farm income without subsidies.

You don't see these costs at the store. The U.S. government is quite content with our 0.2% of organic land. You can buy organics at the store because you don't want to eat that genetically engineered, chemical-soaked food—but, better yet, you could grow your own.

Aside from avoiding the chemical contaminants on conventionally grown food, organic food also has more vitamins and minerals. There are differences between plants but, on the whole, organic foods contain 30% more vitamin C, 21% more iron, 29% more magnesium, 13% more phosphorus, and 15% less

nitrates.

They have higher levels of polyphenols, which are cancer-fighting antioxidants. And that's comparing apples to apples and corn to corn, not corn to the highly-processed corn flakes or chips at the store.

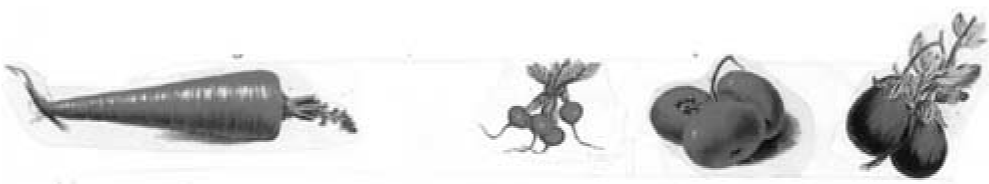
Growing your own food also prevents the environmental degradation that results in having your food transported from thousands of miles away. The other day, somebody was talking about how they had bought cans of Georgia peaches, but upon looking closer they found that these Georgia peaches had been packed in China! How much fossil fuel was burned in order for folks to be able to buy cheap cans of Georgia peaches?

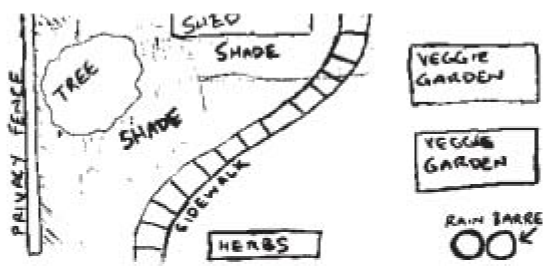
During apple season in Minnesota, we're still trucking in apples from Washington state. When you grow your own food, you ensure that your food was grown locally and not brought from thousands of miles away for consumers to save a buck at the grocery store. This current system of using massive amounts of oil both to produce crops and to transport them is not sustainable!

Of course, all the good reasons in the world don't mean much unless you get some benefit out of it. Something you can be passionate about is good-tasting food. Aside from the ecological and health benefits, your garden vegetables are going to be more fresh and tasty. Your carrots won't sit in your fridge getting dry and cracked because you can pull fresh ones out of the ground when you want them. I love going out to the garden for fresh tomatoes to put on sandwiches and salads, or for making a jar of salsa.

Lastly, gardening is fun. Some folks think about hoeing, weeding, and difficult tasks; I think about spending time outside. Weeding doesn't bother me. I'll look at how my beans are growing or see if I have any flowers on my tomato plants yet. While I'm out there, I'll squat down and pull up a few weeds. If it's that time of year, I might pick some veggies and sample a few while in the

garden. I watch the bees enjoying the flowers in the herb garden. I see what other insects are making homes in the garden. I feel the sun on my skin. I smell the different plants. After spending a good portion of my day around unnatural things, it's nice to spend time among the plants.





GROW YOUR OWN FOOD

Gardening is something that has really stuck with me. I have a tendency to get obsessed about something and spend a lot of time and money on it and then get tired of it and move on. But some things in my life are constant. Bicycling is one, and gardening is another.

I had my first garden when I was about 10 years old. In back of our house was a little square of sandy dirt which I was allowed to plant something in. We planted seeds from the food we ate: lemon, apple, avocado, melon, tomato.

After I got married, had a child, and settled down a bit, I tilled up a little garden bed in the shade of a tree in the backyard of the duplex we were renting. I didn't dig very deep because of the tree roots. I'm a bit surprised anything grew—we grew some snap peas and enough cucumbers to make pickles.

Since then I've read and gardened a lot more, and it's still a challenge. Gardening is all about trying to harness nature and make it do your bidding, which is bound to fail at times. Someone once said, "I'm a very old man, but a very young gardener." As long as you keep gardening there is always something new to learn.

WHERE TO PUT YOUR GARDEN

Most vegetables prefer full sun and no tree roots. Many yards don't offer one of those, let alone both. Then you have to consider other uses for the backyard, like if the kids need a place to play.

As you're deciding where to put your garden, pay attention to how much sun different areas of your garden get. Some books tell you to map out your yard to show what areas get shade during different parts of the year.

I don't have patience for that. I do my best to pick out a sunny spot and put my garden there.

You'll also want to consider easy access to water. Make sure you can reach the garden with your hose. It may be helpful to choose a site close to rain barrels.

You'll want a place that has good drainage. If there's a low-lying area in your yard where water will pool during the spring, that's not going to be the place to plant your garden. Also, low-lying areas tend to collect cold air. They can get hit by frost (which can kill your plants) while everywhere else is frost-free. If there are sections of your yard that get really windy, that can be tough on your plants.

These are all things to consider. There's not much chance you're going to find the perfect place to plant a garden, and you don't need to find the perfect place. Find the best place possible and work with what you've got.

RAISED BEDS

Raised beds make gardening much easier. You don't have to till up the sod to get started—you build your raised bed right on top of the grass. And raised beds lend themselves to intensive planting.

Raised gardens have good drainage. No matter what kind of soil they're sitting on, the water moves easily through the loose soil. If the bed gets overwatered, the extra runs out the bottom. Raised beds can be built about anywhere, even directly on top of concrete. These beds would have to be deeper than ones you use in your yard, but if you only have room for a garden in your driveway, then this could solve your problem!

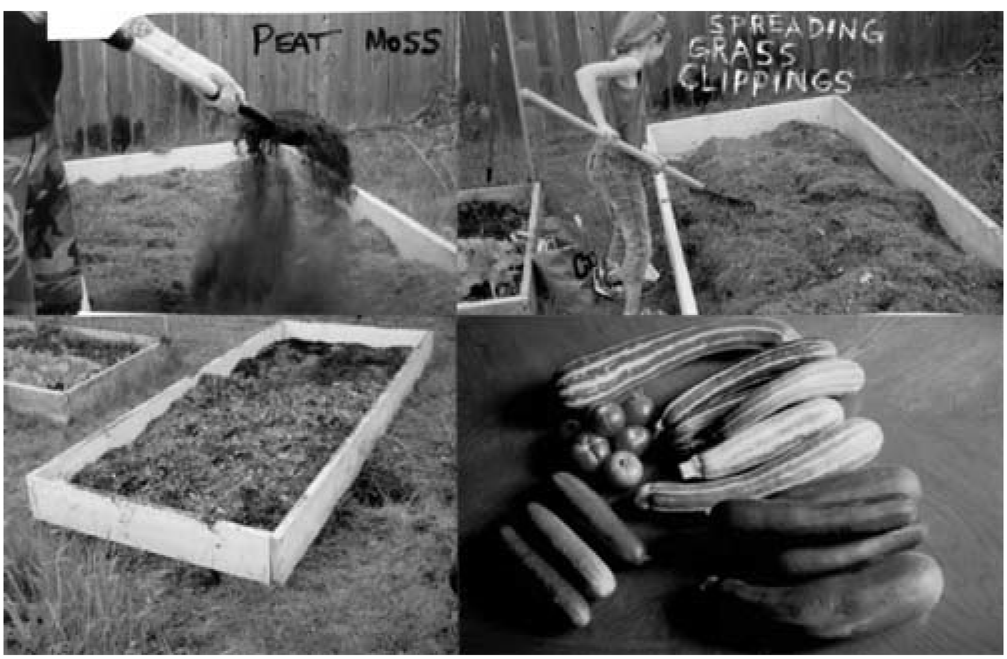
Raised beds can be built out of a variety of materials. I always build mine out of wood planks, but I've also seen them made from bricks, masonry blocks, concrete, and metal pipes. You can use an old metal trash bucket or watering trough.

The jury is still out on using tires—there are concerns that they may leach chemicals into the soil. You definitely should not use anything treated with creosote, as it is highly poisonous—this includes railroad ties and telephone poles. I think green treated-wood has been mostly phased out in favor of brown-treated wood, but I don't trust either one of them. For years they told us green-treated wood was safe, while it leached poisonous arsenic into the soil. I don't want anything unnatural around my plants so I always use untreated wood.

If I'm buying wood, I usually buy 2x10 or 2x12 planks. If I'm able to salvage wood, I'll build them from whatever I have on hand. I dumpstered a whole bunch of 2x6s this year, so that's what I used in my greenhouse. When we built Rachael's herb garden, we used some 1x6s I had laying around. Five

years later, they're still holding up.

4' is a very good width for a raised bed. Most people can reach 2' into the center of the bed, which means that you'll be able to reach the entire garden without stepping in it. The beds can then be as long as you want.



Once you decide on a size (or it's been decided for you by what wood you have on hand), you only need to cut the boards and screw the corners together. I have used nails before, but the weight of the soil ends up pushing the corners open and it's very difficult to screw it back together. So do it right the first time and screw it.

I like to use lag bolts. First, put the whole thing together using a couple nails on each corner. This holds the boards together while you do the drilling and screwing. Then pre-drill two or three holes for lag bolts on each corner. If you have a socket driver for your drill, that really speeds things up. Put a washer on the lag bolt and drive it into the pre-drilled holes. If you don't have a socket driver, use a socket wrench or even an adjustable wrench.

Once you get the box screwed together and set in place, do your best to level it out (if necessary) by putting blocks of scrap wood under the corners that are too low. When you fill in the bed with soil, a little bit will end up underneath the planks and then your soil has self-leveled without a lot of work on your part.

SOIL

Now you'll need to fill your beds with soil. You can buy poor-quality soil from a garden or hardware store for about $1 for a 40 pound bag—approximately one cubic foot.

In some places you can find organic soil in bulk. Though it is still fairly cheap, the cost of delivery doubles or triples the price. The delivery cost is usually a set amount no matter how much you buy, so the price per cubic yard gets cheaper the more you get. You can further reduce your cost by splitting a load with a friend.

Either way you'll have to figure out how much you need. To do this, multiply the dimensions of your bed in feet. The beds I often build are 4x8x1'. So each bed holds 32 cubic feet of soil. A cubic yard of soil is 27 cubic feet, so one of those would almost fill up one of my beds.

To find out how many cubic feet your garden holds, multiply it's dimensions measured in feet.

Before you start putting your soil in your bed, put down newspaper to keep

all the grass and weeds from growing up into your bed. Someone did a study on this and determined that seven layers of newspaper is the perfect amount to keep weeds from coming up while still allowing roots to grow down. I've also used cardboard and brown paper bags. The main thing is that you have to overlap all the pieces. Don't put them down edge to edge or the weeds will come up in between.

Once you have your layers down, wet everything before you start putting your dirt in. This technique saves you the trouble of tilling the soil. The wet paper smothers anything underneath your bed, but as it decomposes it will allow roots to penetrate into the soil below.

BUILDING YOUR OWN SOIL

You can make your own soil using sheet composting, or "lasagna gardening." Instead of composting in piles, you take organic material that would normally go into your compost bin and spread it out on the ground, along with other layers, where your garden will be. When the compost is done, you plant your seedlings and seeds right into your compost.

The first time I did this I laid down a whole mess of grass clippings, half a bale of peat moss, and a compost bin full of unfinished compost. On top of that I put enough soil to cover it all, six or seven of those $1 bags. The bagged soil didn't hold moisture very well and would get a rock hard crust on the top that no seedling could break through. I transplanted some seedlings in there and they did great. I got a ton of zucchini!

After I built new beds, I started with layering leaves. They decompose slowly, so they're best kept on the bottom. I put on some grass clipping and then spread compost on top of that from my bin. This time I tried some different: soil on one section and another section with no soil on top. The soil seems necessary if you're going to be planting seeds, but for transplanting seedlings the straight compost worked fine. I do find it easier if the top layer is at least

partially finished.

You can also spread out your materials and then let them break down before you start planting. Do this in the fall and it should be ready by planting time. If you don't start until spring, allow it all to decompose for a few weeks before starting your garden.

Just about anything that you would put in your compost bin will build your soil directly in the garden bed. Think about what resources you have available and use them. Your materials might look different from someone else's, but as long as you're using compostable materials you should be safe.

Examples are:
- leaves
- grass clippings
- peat moss
- hay
- manure
- sawdust or wood chips (use these sparingly as they have a very low nitrogen content and could make your soil too acidic)
- plant waste (corn stalks, dead plants from your garden or house, cut flowers)
- vegetable/kitchen waste (I use this sparingly because too much vegetable matter could make things stinky)
- wood ashes
- coffee grounds (use sparingly and mix well because these are acidic and sour easily)
- of course, you can use finished or unfinished compost or vermicompost

Compost is an important part of keeping the soil healthy and productive. If you're not going to do sheet composting directly in your garden bed, compost somewhere and use the finished compost in your garden.

Compost is nature's way of replenishing the soil. When gardening organic, we

don’t feed only the plant (and not with synthetic nutrients): we also feed the soil (and with natural nutrients). It in turn feeds the plants. If you have healthy soil, you have healthy plants.

In nature when something dies, it falls to the ground and nourishes the very spot where it once lived. Our agricultural system in the U.S. is seriously flawed. Whatever is produced on the farm is shipped away and nothing natural ever comes back. The wastes are never returned to the soil; they end up in a landfill. The soil is never replenished, so the plants have to be fed with chemical fertilizers. Using compost avoids that.

Although compost isn’t particularly rich in commerical fertilizer’s three main minerals, it’s packed with beneficial root-colonizing microbes. These can act as extended root systems or as catalysts—helping the plants squire the minerals they need from the soil.

COMPOSTING SIMPLIFIED

Composting is probably the easiest and most efficient way to reduce waste. Yard waste comprises more than 20% of America's garbage at 230 pounds per person per year. Add in food wastes at 9% (100 pounds per person per year) and you've accounted for almost 1/3rd of America's waste. It takes more work, but paper and cardboard can also be composted. These three combined is almost 65% of America's trash!

If you own your house, it could save you a good amount of money, since some cities charge for each bag of lawn waste they haul away. And you end up with compost which can be used to mulch your plants, which fertilizes them and betters your soil! It can also be dug directly into the soil or mixed with soil to pot plants.

Compost books turn this procedure into C:N (carbon to nitrogen) ratios, protozoa, actinomycetes, psychropholic and mesophilic and thermophilic bacteria, and aerobic versus anaerobic decomposition. Those are all an integral part of the process but make this seem more complicated than it actually is.

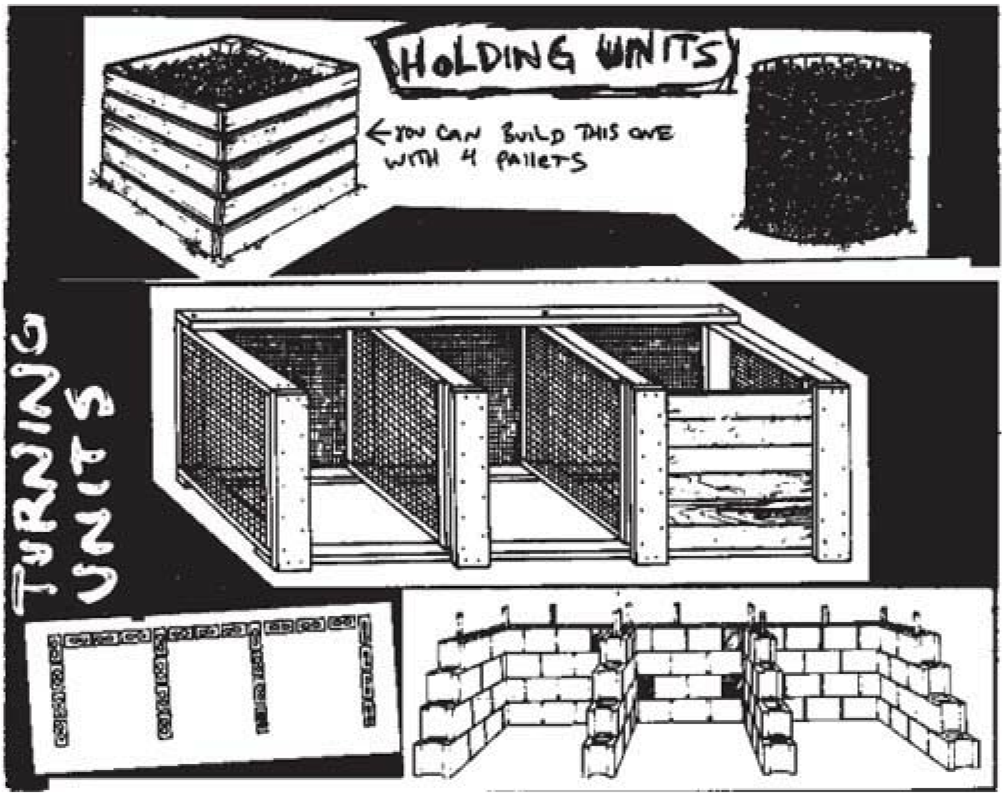
Compost happens without any assistance from nature. Leaves and branches fall off the trees, collect on the ground, and naturally decompose. It doesn't require any assistance or fancy tools to keep the process moving along. All it

takes is organic material, air, and moisture.

There are a couple different methods of composting. You can use a holding unit, which is a container where you throw your yard wastes and kitchen scraps but never do anything with it. It can be made out of boards, old pallets, chicken wire, or snow fence—pretty much anything that is going to allow some air movement. The main downfall of this method is that it's very slow. It can take up to two years to fully decompose, so you run out of room in a hurry.

The heap is pretty much the same thing as the holding unit but without any containment. It should be no larger than 5' wide by 3' high but as long as you need. This allows air and moisture into the pile. Larger piles compress too much. Heaps are also easier to turn than the most permanent of holding units. However, unless you have a lot of room, you probably don't have space for a heap.

Your best bet is a turning unit, which is a series of holding units. You build a good pile and turn it every five to twelve days. After you have your bins, it ends up requiring half an hour of work per week for a normal-size yard. And after a month or two, your compost should be finished.



A compost bin should be at least 3x3x3' and no bigger than 5x5x5'. A pile smaller than 3x3x3' won't heat up or retain heat as well, which slows down decomposition. A pile larger than 5x5x5' won't allow enough air in and the pile will begin to anaerobically decompose. When you have plenty of air, provided by a well-ventilated and occasionally-turned pile, it decomposes very quickly—so quickly that it heats up to as much as 160 degrees Fahrenheit!

This not only speeds up the process, it kills weeds' seeds and unwanted pests like fly larva and eggs. If there is not enough air, the pile decomposes slowly, smells bad (because it releases ammonia gas) and can ferment, which is no good for your plants.

If you've got everything else right and your compost smells like rotten eggs, you've got a problem with content. Compost needs to have a mixture of dry, woody materials like dry leaves and grass clippings (high carbon content) and wet or green materials like fresh grass clippings and kitchen scraps (high

nitrogen content).

Never add meat or dairy as they will make your pile stink and attract pests. Avoid starchy foods like bread or pasta. A compost pile needs a lot more carbon than nitrogen and if you get too much nitrogen it will stink.

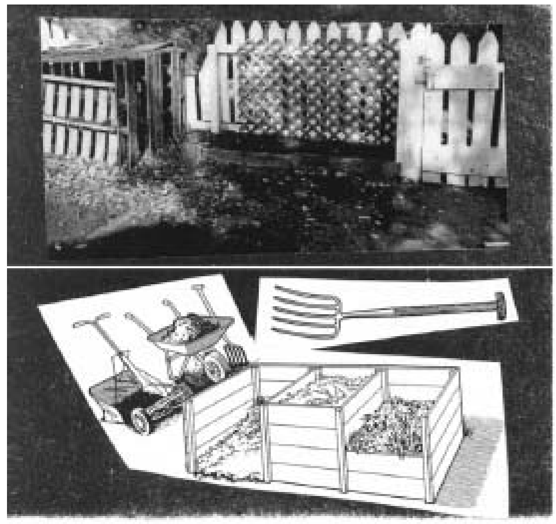
The best way to take care of this is to turn your compost and add dry leaves or something similar to dry out the pile.

Your compost should be moist but not sopping wet. A fistful of compost tightly squeezed should yield a drop or two or water, no more. Turning your pile is easiest with a pitchfork and the best kind has five oval-shaped tines.

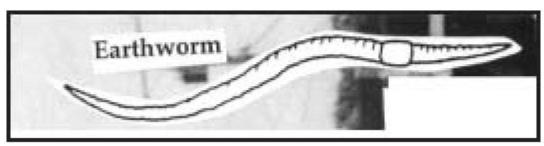
If you have a series of bins, turn it from one to the other. Dig out the sides and top of the pile, put the center out to the sides, fill in the middle, and cover it up. This ensures everything gets heated and evenly composted.

The compost is finished when the pile no longer heats up and is about one-third its original size. It will be dark, crumbly, and have a nice earthy smell. You can use it to mulch your garden or your trees or to grow potatoes. You can spread it around your yard and it will improve your soil and help prevent thatch.

When using your compost in potted plants or as a top dressing, make sure you have completely finished compost without big pieces in it. This is generally accomplished by sifting the compost. I made a sifter by stapling a piece of hardware cloth to a couple of scrap 2x4s. I set this on top of the wheel barrel, shovel compost onto it, and then push the compost around. Whatever falls through into the wheel barrel is completely “finished” and anything that doesn’t is thrown back into the compost bin.



If you don't have the space or material for a standard compost pile, you might try worm composting. This can be done about anywhere, often in the kitchen or basement. I've even considered doing it at work to see if I could get away with it!



WORM COMPOSTING

I'm always looking for a new way to reduce waste and make myself a little more self-sufficient. Becoming less dependent on the garbage collector is one way to do that. So is growing my own food. Composting helps out with both of these.

Composting isn't always as easy or efficient as I'd like. There are things you can't use, it's difficult during the cold northern winter, and it takes more work than I'm willing (or sometimes able) to give. Vermicomposting (composting with worms) solves many of these problems.

Worms eat garbage. That's their job in the world. They live in the dirt, come up to the surface to get decaying vegetable matter, eat it, and turn it into

nutrient- and bacteria-rich castings. In a worm bin, these castings mixed with other decaying vegetable matter form vermicompost.

The worms in your garden help aerate the soil by tunneling, but these garden worms are not the type you want in your worm bin. The best type for your bin are red worms (Eisenia Fetida). These worms are truly garbage eaters, consuming their body weight every two days. Unlike garden worms or nightcrawlers, they need almost no soil at all and will put up with having their environment disturbed.

In a normal compost bin, you have to shy away from pasta, bread, or almost any starchy foods, dairy, or even too much vegetable matter. Worms, on the other hand, will eat about anything you give them. Fruit and veggie waste is great. You can also throw in your plate scraps: eggs, cheese, bread, pasta, even small amounts of meat can be added, provided they're buried well. I don't recommend putting meat in your mouth, let alone in your worm bin. Another benefit comes at fridge-cleaning time. Worms don't care about mold, so that old mac and cheese, stinky rice, leftover casserole, and unidentifiable goop are all fair game.

Coffee is good for adding grit to the bin, but too much can cause your bin to become too acidic. Egg shells are a great addition to your worm bin, adding grit and supplying calcium carbonate to your worms, and later on to your plants. Let them dry out and then crush them with a rolling pin or jar.

One thing to be careful about is too much citrus. There is a chemical in citrus fruits that can kill worms, so add sparingly. Among the few things you shouldn't put in your bin are feces and anything not biodegradable.

Plants greatly benefit from vermicompost. It's full of nutrients and rich in humus, which makes those nutrients more readily available to the plants, as well as aiding in aeration and water absorption. I like to work a bunch of compost into the soil right before planting, and then use it again to mulch my

plants after they've gotten a good start. Vermicompost is also good for top dressing houseplants. Or throw a handful of it in the bottom of the pot when you're doing your transplanting. You won't have a whole lot of this stuff. Composting generally reduces the mass of waste by about two thirds. So use it where you need it most.

One thing I like about this system is that the vermicompost feeds my plants which then feed me. Then the scraps are returned to the worm bin, which feeds the worms, which create vermicompost to feed my plants. There's a little loop of self-sufficiency!

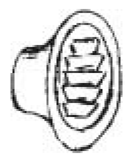
I'm going to keep things simple and practical here. If you need more information or want to explore some other options, check out Mary Applehof's book *Worms Eat My Garbage.* She covers vermicomposting quite extensively.

All you'll need to get started is a bin to keep your worms in, newspaper, water, and a little bit of dirt. A pound of worms will consume about 3.5 pounds of waste each week, but you're going to need to give them room. A cubic foot of bedding for every pound of food per week should do. Red worms eat from the surface, so surface area is the most important measurement. If you have a 2x2' container that is 4' deep, you've really only got 4 square feet, or enough space for four pounds of food a week. If you had a container 2x4 feet by 2' deep, you've got eight square feet, enough space for eight pounds of food a week.

Let's assume you've got about 4 pounds of food a week you could feed to your worms. This could easily be accomplished with a 4x1x1' "window" bench. If you eat twice that much, a 4x2x2' garden bench might be right up your alley. Both of these can be built in an afternoon from one sheet of plywood and a few 2x4s.

I prefer wood over plastic for the bin. It breathes better and absorbs excess

water. A wood container with a lid looks nicer and can double as a bench. The problem with plastic is that if there is too much water, there is nowhere for it to go. It condenses on the top and sides and drips down to the bottom where it collects in a pool. The worms don't like too much moisture. And red mites thrive in these conditions and will multiply like crazy until there are so many that the worms refuse to eat. But if you're not real handy with tools or don't have the time to build something, there are many easy-to-find plastic containers that will do. Rubbermaid tubs, old coolers, and even garbage cans or buckets will work.



Any bin you use will need to have air circulation. Drill a few 1" holes in the front and back of the bin. In the front, keep them a bit closer to the top; on the back, a bit closer to the bottom. Soffit vents make things look a little nicer and keep the bedding from falling out of the holes. Go to your local hardware store and ask for 1" soffit vents. They only cost about 70 cents a piece, costing you around $7 for your whole bin.

Give some thought as to where to put your bin. Worms work best in temperatures ranging from 59 to 77 degrees Fahrenheit. Below 50 degrees they'll go into hibernation. Temperatures below freezing can kill them. A partially shaded area in your yard will probably be fine for most of the spring, summer and fall, but a cold northern winter will probably kill them.

One solution is to bring in a small amount of your worms for the winter. You can keep a small bin inside and feed them enough to keep them going until spring when you can use them to inoculate your new bin.

Keeping your worm bin inside year-round brings up other considerations. Worm bins are pretty trouble free, but small problems like a bit of a smell or

fruit flies, which you wouldn't notice outside, can be aggravating inside. These problems can be easily remedied, but if you'd rather not have them crop up in your kitchen, choose someplace else. A basement that is comfortable for you year-round will probably be comfortable for your worms year-round. A few fruit flies in your basement aren't as bothersome as those same fruit flies in your kitchen.

Once you've picked out your bin and know where you're going to put it, you'll need bedding. This is where the newspaper comes in. Even if you don't get "the paper", you'll probably have enough if you save up your local arts papers and junk mail. If not, check gas station dumpsters on Monday morning when they throw out the stack of unsold Sunday papers.

Figure out how big your bin is. You'll need 3 pounds of newspaper per cubic foot; or if your bin is marked in gallons you can figure it at 4/10ths pound per gallon.

Weigh your newspaper and then shred it into strips about an inch wide. None of this has to be exact. It's worms we're talking about here!

Next thing you'll need to do is add water. Worms like their bedding to be around 75% wet, so add three pounds of water for every pound of newspaper. Once again, you can weigh this on a bathroom scale or figure that one gallon equals 8 pounds.

Find something big to mix your stuff in (like a garbage can) and throw in half the newspaper and half the water. Mix it all up and throw in a couple handfuls of dirt. This adds grit to the bedding, which the worms will need to digest the waste. Then throw in the rest of the newspaper and water and mix it all up. Make sure all the paper gets wet.

If you're using a plastic container for your worms, it's a good idea to only start out with 50% moisture, or two pounds of water per pound of newspaper.

You'll be adding moisture every time you add waste, and excess water won't escape as easily from a plastic container.

Red worms reproduce quickly. If you start out with one pound of worms but enough room for two pounds, they should fill out the area in short order. But they won't overfill your container. Their growth is checked by food and space. Worms' castings are toxic to them (much like our "castings" are toxic to us), so when the castings start to build up and food starts to wane, worms will die.

If you continue to let the worm castings build up without adding fresh bedding, most of the worms will die. You can add more and more food to support the ever-increasing numbers, but eventually you'll have to harvest the compost and worms for your garden or a friend.

One way to harvest is to move all the worms, bedding and casting to one side of the bin. Alternately, if you have a friend who is starting a bin, you can give half to him or her. Fill in the newly empty area with fresh bedding and start adding new food waste. The worms will naturally head toward the fresh bedding to get away from their own waste. If you're giving a lot of worms away, you'll need to give the worms a bit of time to get their numbers back up, so hold back on the waste a little bit. It shouldn't take them long.

After two or three months, remove the old bedding (now vermicompost!) and the few worms remaining on that side to use on your garden or plants or whatever. Fill this empty area with new bedding and start again.

There will be other bugs in your bin besides worms! If you open up your bin and see a few mites, beetles, or a millipede, don't be alarmed. They're supposed to be there. Worms aren't the only thing eating your garbage. Molds, bacteria, and other bugs help each other break down the waste and keep each other in check.

PROBLEMS

Too much moisture in your bin: This is a problem which you will probably

notice with your nose first. If you let it slide, you'll see an overabundance of brown mites or fruit flies. I've never run across this problem with my wooden bin. On all of my plastic bins, I drill one extra hole in one corner on the bottom of the bin and put a cork in it before filling the bin. If water starts to pool in the bottom, I pull the cork, tilt the bin and drain it. If you don't have a drain, you can suck excess water out with something like a turkey baster. Adding new, dry bedding often does the trick. You can also dry out the bin by leaving the lid open or slightly open for a day or two.

Smells: Most worm bins don't smell much or at all. But if you add too much waste, it will start to rot because the worms won't be able to consume it all. Not burying your waste sufficiently will cause the same problem. Too much moisture or an insufficiently vented bin will also smell. You can solve most of these problems by turning up your bedding. Shuffle things about a bit to get air mixed in, and make sure all the waste is buried when you're done. If you're adding too much waste, get a bigger bin or add less.

Fruit flies: I hate flies! You bring them in on fruit, and they end up flying around in your kitchen and finding moist places in your house to live and breed. Flies lay their eggs in exposed food matter. The books say that if you bury your food well you should be able to avoid this problem. It hasn't worked for me, but then I don't even need the worm bin around to have a fly problem.

WORM BIN

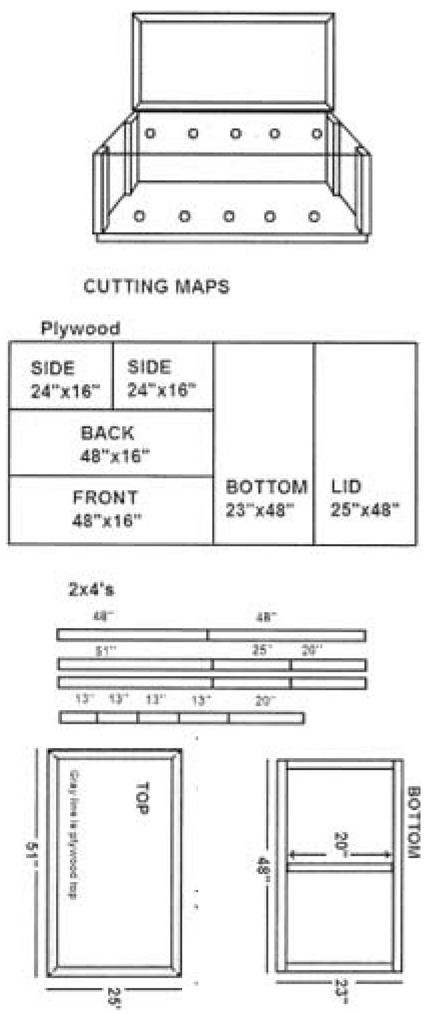
This bench doubles as a worm bin. It can be built from:
- one ½" thick 4'x8' piece of plywood
- three 8' long 2x4s
- one 6' long 2x4

Start by cutting everything to size. This design has no waste. You use every bit of each piece of lumber. However, when cutting, the saw can eat up to 1/8", so

when you cut the plywood, cut the top piece last. It'll end up a little under 25" wide, but that will work fine.

Next, you'll build the top and bottom. The bottom is fairly easy: you screw the 2x4s together and then screw the plywood to the top of them. The top is a little trickier because it involves mitered joints. You'll need to cut the ends of the 51" and 25" 2x4s at a 45 degree angle.

This will give you a rectangle a bit larger than the 48"x25" plywood top. This way, the cover overlaps a bit which keeps rain from running in and drowning your worms. Once you get the 2x4s screwed together, center the plywood top and screw it on.



Next, build a box using the front, back, sides and the four 13" long 2x4s. Screw the 2x4s to the front and back, and then add the sides. The plywood will be longer than the 2x4s. This is intentional. It allows the plywood to slip over the base.

The plywood fits above the ground so as not to be in constant contact with a wet surface. Once you have your box made, slip it over the base and attach it in place.

Attach the lid with hinges. I added a length of vinyl rope so that the top wouldn't fall all the way open. It would open just far enough to hold itself open, without resting its weight entirely on the hinges.

You'll need ventilation holes. Five in each the front and back should do it. Remember to put the holes on the front low and the ones on the back high (or vise versa) to assist air movement. For a nicer look, use soffit vents in the holes.

COMPANION PLANTING

When gardening organically, you can't grow things the way factory farms do. Growing huge blocks of the same plant requires pesticides, herbicides, and fertilizers. We don't find monocultures in nature because they can't support themselves.

Nature creates a diverse system that works together. If one plant started to develop a monoculture, nature would balance it out. As nutrients in the soil are depleted, plants become weaker and more susceptible to disease. A large area of one kind of plant creates a feast for insects or animals who eat that plant.

Last year, I planted all of my cabbage in one place and the cabbage worms went from one plant to the next so fast that I couldn't stop them. I had to pull up the most infected plants and hope to save the others. Had I mixed in other

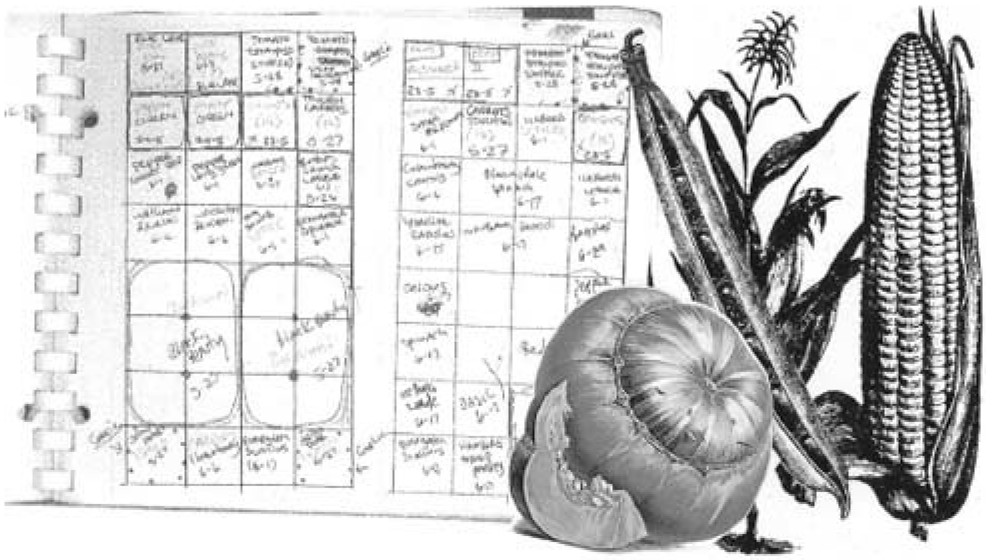
plants or spread them out among a couple of beds, it would be very unlikely to have a problem.

Companion planting is nothing new. There's evidence of it being used for thousands of years. Most gardeners have heard of the "three sisters." Native Americans traditionally planted corn, squash, and beans together because they all help each other grow. The corn being a heavy feeder is helped by the beans who fix nitrogen into the soil. The beans are helped by the corn which gives them something to climb on. The large leaves of the squash protect the plants from predators like raccoons, who love corn but not making their way through squash leaves to get it. It also shades the soil to preserve water for all three plants.

Some deny the scientific validity of companion planting, dismissing it as nothing but old wives tales. However, since only 0.1% of FDA money goes to study organic growing, all we can really know is what we experience ourselves.

That leaves us trying to answer our own questions. How close is close enough for good companions? How far is far enough for antagonistic plants? With some, it's easy to figure out. Beans should be planted close enough to corn so they can climb. Same goes for sunflowers and cucumbers. Wormwood is planted as a border.

In many cases you have to do your own research by trial and error. Beans and onions are mortal enemies, but exactly how far apart do they need to be kept? How close does marigold need to be to deliver its beneficial properties to other plants? Do carrots and tomatoes love or antagonize each other?



Some plants release natural substances that improve the flavor or growth of other plants. Dill improves the health of cabbage; sage deters a host of harmful insects. Leeks improve the growth of carrots as well as repelling carrot flies. This year I'll be planting some mint near my cabbage to try to keep those cabbage worms away.

Through my own experience and reading, I've put together a chart of plants that make good and bad companions, and included the insects they attract or repel. Use this as a starting point for your own experimentation.

The purpose of intensive planting is to harvest the largest amount of produce possible without the use of synthetic pesticides or fertilizers. This style of planting resembles nature. In nature, plants don't grow in evenly spaced rows. In traditional row gardens, much of the available area is taken up by the space between rows. If you're using machinery to cultivate your garden, you'll need this space. With intensive planting, however, you do all the work by hand or with hand tools.

Intensive gardens also leave less work to be done. The leaves of the plants shade the soil, discouraging weed growth and keeping the soil cool and moist for good root growth. Having the plants close together also means that you're

only watering and fertilizing areas where plants are actually growing, and not wasting resources on bare paths between rows.

Instead of rows, intensive gardens are planted in blocks. Some books tell you to plant everything equidistant, which means using hexagon or triangle planting patterns. I keep it simpler by planting in squares.

For example, the packaging on head lettuce will usually tell you to plant them in 12” apart in rows 18” apart. I disregard row spacing instruction entirely and only pay attention to plant spacing. I plant one or two head lettuce seeds in the middle of a square foot. If you were planting multiple squares of lettuce, this would leave them 1’ apart in each direction. However, this leaves a lot of room between plants that are going to take 75 days to mature. So I’ll plant some faster growing leaf lettuce in the corners. By the time that’s ready to pull up and eat, the head lettuce has grown enough that it needs the extra room.

Leaf lettuce calls for 6” plant spacing, so on its own, it would be planted in 6” squares. If you were to plant them in rows, as instructed, you would get 21 plants in nine square feet. Planted intensively, you get 49 plants in that same space!

And that doesn’t even take into consideration interplanting with companions. Radishes only take 30 days to mature, and leaf lettuce makes them more tender. I almost always plant garlic around my tomatoes and intersperse onions with my lettuce.

One of the benefits of planting in blocks is that you can scatter your plants around the garden. Most pests are plant-specific, so if you have all your cabbages together a cabbage worm infestation will quickly spread to the entire crop. But if you have scattered the cabbages around your garden, you can control the problem quickly by pulling up the affected plant.

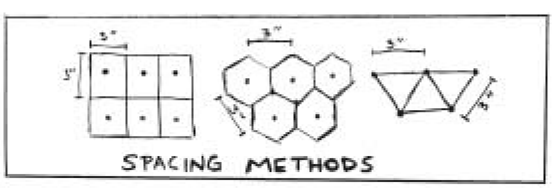
It’s a waste to do what seed packets tell you to and plant a whole bunch of seeds only to pull up most of them later. New store-bought seeds have a germination rate of almost 100%, and your saved seeds should be only slightly less. Seeds will last from season to season, so don’t worry about using up all your seeds this year. Older seeds may have a lower germination rate—if you’re worried, do a germination test.

Intensive gardening lends itself well to succession planting. For example, when you harvest your early crop of peas or lettuce, you can plant a warm-season crop like tomatoes or beans in its place. If your season is long enough, you can follow that up with another cool-season crop.

Because you’re planting smaller blocks, you can plant them so that your entire crop isn’t ripe all in one week.

If you need to do all your planting at the same time, choose an array of varieties. My array of tomato seeds mature in anywhere from 55 to 90 days, so I can plant them all at once without having to harvest an overwhelming load of tomatoes all at once.

Another strategy is to continue planting throughout the year. Radishes, for instance, take 30 days to mature.



PLANT SPACING

Just in case you haven't ever really looked into it before, here are examples of some the the spacing for intensive planting.

Beans 6"	Beets 4"
Broccoli 12"	Cabbage 15"
Head Lettuce 12"	Leaf Lettuce 6"
Onion 3"	Radish 2"
Peas 4"	

COMPANION PLANTS

PLANT	Beneficial Plants	Antagonistic Plants
Alfalfa		
Asparagus	Tomato, Basil, Parsley, Capsicum, Lettuce,	Potatoes
Basil	Tomatoes, peppers, oregano, asparagus (most veggies & herbs)	Rue
Beans	Carrots, Cabbage, Cucumber, Cauliflower, Potato, Summer Savory, Corn, Lettuce, Eggplant, Strawberry, Celery, Radish, Spinach, Melons,	Leeks, Chives, Garlic, Onions
Broad Beans	Potatoes, Lettuce	Fennel
Bush Beans	Strawberries, Grapes, Sunflower, Cucumbers, Potatoes, Corn, Celery, Summer Savory	Garlic, Onion
Beetroot	Kohlrabi, Onions, Chives, Lettuce,	Bush Beans, Lettuce, Cabbage, Leaf Mustard, Garlic
Borage	Tomato, Squash, Strawberries,	
Broccoli	Dill, Celery, Chamomile, Sage, Rosemary, Onions, Leeks,	Tomatoes, Strawberries, Oregano
Brussel Sprouts	Potatoes, Sage, Hyssop, Thyme	Strawberries, Rosemary
Cabbage (these apply to most members of the cabbage family: broccoli, brussel sprouts, cauliflower, kale, kohlrabi)	Beetroot, Potatoes, Beans, Onions, Sage, Celery, Dill, Chamomile, Thyme, Mint, Rosemary, (aromatic plants deter cabbage worms)	Tomatoes, Garlic, Strawberries, Celery, Dill, Mint, Thyme, Oregano
Capsicum	Basil	
Carrots	Leeks, Lettuce, Onions, Peas, Tomatoes, Chives, Leeks, Rosemary, Sage, Tomatoes,	Dill, Parsnip, Chives, Sage, Rosemary, Radish
Catnip		
Cauliflower	Celery, Celeriac, Beans, Oregano, Onions, Leeks,	Strawberries, Rue, Peas, Potato, Nasturtium
Celery	Leeks, Bush Beans, Cabbage,	Parsnip, Potato, Wheat, Corn

	Tomatoes, Onion, Spinach	
Chamomile	Cabbage, Onions, Cucumbers,	
Chives	Carrots, Cabbage, Tomatoes, Parsley, Parsnips, Fruit Trees	
Corn	Melons, Squash, Pumpkins, Cucumbers, Potatoes, Parsnips, Artichokes, Jerusalem Artichokes, Peppers, Beans, Peas,	
Cucumber	Beans, Peas, Radish, Celery, Carrots, Beans, Artichoke, Beets, Nasturtium,	Potatoes, Sage, Cauliflower, Basil
Dill	Cabbage, Carrots, Lettuce, Onions, Sweet Corn,	Carrots, Caraway, Tomatoes
Eggplant	Beans, Potato, Marjoram, Peppers, Lettuce,	
Fennel	(Most plants dislike fennel)	
Garlic	Roses, Raspberries, Cucumbers, Peas, Celery, Lettuce, Apples Trees, (plant with herbs to enhance essential oil production)	
Horseradish	Potatoes, Fruit Trees	
Hyssop	Cabbage, grapes	Radish
Kohlrabi	Beetroot, Onion	Pole Beans, Tomatoes, Cucumber
Leeks	Cabbage, Carrots, Celery, Celeriac, Strawberries, Onion,	
Lettuce	Strawberries, Cabbage, Carrots, Onions, Beetroot, Radish, Corn	Parsley, Beans, Beetroot, Parsnip
Marigold		
Mint	Cabbage, Tomatoes,	
Nasturtium	Cabbage Cauliflower, Cucumber, Tomatoes, Radish, Fruit Trees,	Broccoli, Brussel Sprouts, Potato, Radish, Squash, Zucchini, Fruit Trees
Onions	Cabbage, Carrots, Beetroot, Lettuce, Strawberries, Tomato, Beans, Summer Savory, Chamomile, Leeks,	Beans, Peas, Parsnip, Parsley, Leeks
Oregano	cabbage family	

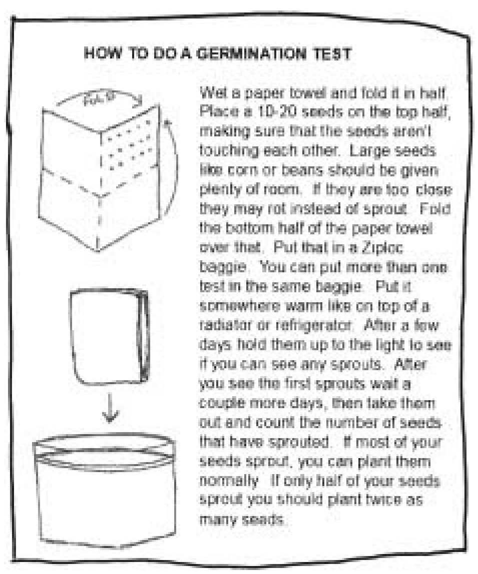
Parsley	Tomato, Asparagus, Carrot, Mint	
Peas	Squash, Cucumber, Radish, Turnip, Corn, Carrot, Beans	
Potato	Beans, Corn, Cabbage, Horseradish, Marigold, Limas, Eggplant (as a trap for potato beetles)	Pumpkin, Squash, Cucumber, Dill, Eggplant, Tomatoes, Raspberries
Peas	Carrot, Corn, Cucumber, Beans, Radish	Onions, Garlic, Shallot
Pumpkin	Sweet Corn, Marjoram	Potato
Radish	Cucumber, Lettuce, Kohlrabi, Melon, Peas, Nasturtium,	Hyssop, Squash, Peas, Nasturtium
Rosemary	Carrots, Beans, Cabbage, Sage,	
Sage	Rosemary, Carrots, Cabbage, Peans, Beans,	
Savory		
Spinach	Broad Beans, Strawberries, Fruit Trees	
Squash	Nasturtium, Corn	
Strawberry	Bush Beans, Spinach, Borage, Lettuce,	
Sunflower	Cucumber,	
Tansy	Fruit Trees	
Thyme		
Tomato	Asparagus, Basil, Lima Beans, Cabbage, Chives, Onion, Parsley, Marigold, Nasturtium, Carrot, Limas, Peppers	Beetroot, Fennel, Kohlrabi, Broccoli, Brussel Sprouts, Cauliflower, Potato, Rosemary, Carrots, Chives, Dill, Onions, Parsley, Parsnip, Nasturtium
Wormwood		
Yarrow	enhances essential oil production in herbs	
Zucchini	Corn, Marjoram, Nasturtium, Parsley, Tomato, Spinach, Squash, Capsicum	

PLANTS THAT ATTRACT OR REPEL INSECTS & PESTS

PLANT	**Repels**	**Attracts**
Alfalfa		Assassin Bug, Big-Eyed Bug, Damsel Bug, Lady Bug, Parasitic Wasp,
Asparagus		
Basil	Asparagus Beetle, Fly, Whitefly,	
Beans	Colorado Potato Beetle,	
Broad Beans		
Bush Beans	Mexican Bean Beetle,	
Beetroot	Pole Beans	
Borage	Tomato Hornworms,	Bees,
Broccoli		
Brussel Sprouts		
Cabbage (these apply to most members of the cabbage family: broccoli, brussel sprouts, cauliflower, kale, kohlrabi)		
Capsicum		
Carrots		Assassin Bug, Big-Eyed Bug, Lacewing, Parasitic Wasp, Yellow Jacket Wasp,
Catnip	Ants, Aphids, Colorado Potato Beetle, Cucumber Beetle, Flea Beetle, Japanese Beetle, Squash Bug,	
Cauliflower		
Celery	Cabbage Worm,	
Chamomile		Bees,
Chives	Aphids, Japanese Beetle,	
Corn		
Cucumber		

Dill	Cabbage Looper, Tomato Hornworms, Aphids, Spider Mites	Bees, Swallowtail Butterfly
Eggplant		
Fennel	Aphids, Snails, Slugs,	Syrphid Fly, Tachnid Fly,
Garlic	Aphids, Cabbage Looper, Cabbage Maggot, Flea Beetle, Japanese Beetle, Peach Borer, Onion Fly, Rabbit, Snails, Slugs, Ticks,	
Horseradish	Potato Bug,	
Hyssop	Cabbage Looper, Cabbage Moth, flea beetles	Bees,
Kohlrabi		
Leeks	Carrot Fly,	
Lettuce	Carrot Fly,	
Marigold	Aphids, Asparagus Beetle, Cabbage Maggot, Colorado Potato Beetle, Corn Earworm, Cucumber Beetle, Mexican Bean Beetle, Nematode, Rabbit, Tomato Hornworms, Whitefly,	
Mint	Ants, Aphids, Cabbage Looper, Flea Beetle, Squash Bug, White Cabbage Moth, Whitefly, Mice,	
Nasturtium	Aphids, Cabbage Looper, Colorado Potato Beetle, Cucumber Beetle, Squash Bug, Striped Pumpkin Beetle,	
Onions	Ants, Aphids, Cabbage Looper, Carrot Fly, Colorado Potato Beetle, Rabbit,	
Oregano	Aphids, Whitefly, Cabbage Butterfly, Cucumber Beetle	
Parsley	Asparagus Beetle,	
Peas		
Potato	Colorado Bean Beetle,	
Peas		
Pumpkin		
Radish	Cabbage Maggot, Corn Earworm, Cucumber Beetle, Squash Bug, Squash Vine Borer,	
Rosemary	Bean Beetle, Cabbage Moth, Carrot Fly,	

	Mexican Bean Beetle, Snails, Slugs, Carrot Fly,	
Sage	Black Flea Beetle, Cabbage Looper, Cabbage Maggot, Cabbage Moth, Carrot Fly, Flea Beetle, Slugs,	Bees,
Savory	Bean Beetle, Cabbage Moth, Mexican Bean Beetle,	
Spinach		
Squash		
Strawberry		
Sunflower	Aphids,	
Tansy	Ants, Colorado Potato Beetle, Cucumber Beetle, Flea Beetle, Fly, Japanese Beetle, Mice, Squash Bug, Striped Cucumber Beetle,	
Thyme	Cabbage Looper, Cabbage Moth, Cabbage Worm, Whitefly,	
Tomato	Asparagus Beetle, Cabbage Worm,	
Wormwood	Ants, Cabbage Looper, Cabbage Maggot, Carrot Fly, Flea Beetle, Mice, Whitefly,	
Yarrow		Lady Bug, Parasitic Wasp,
Zucchini		



HOW TO DO A GERMINATION TEST

Wet a paper towel and fold it in half. Place a 10-20 seeds on the top half, making sure that the seeds aren't touching each other. Large seeds like corn or beans should be given plenty of room. If they are too close they may rot instead of sprout. Fold the bottom half of the paper towel over that. Put that in a Ziploc baggie. You can put more than one test in the same baggie. Put it somewhere warm like on top of a radiator or refrigerator. After a few days hold them up to the light to see if you can see any sprouts. After you see the first sprouts wait a couple more days, then take them out and count the number of seeds that have sprouted. If most of your seeds sprout, you can plant them normally. If only half of your seeds sprout you should plant twice as many seeds.

So if you figure you can eat about a dozen a week, plant a dozen a week.

You'll continually have fresh radishes instead of having six dozen one week, taking up space and going bad before you can eat them.

MAKING VERTICAL SPACE

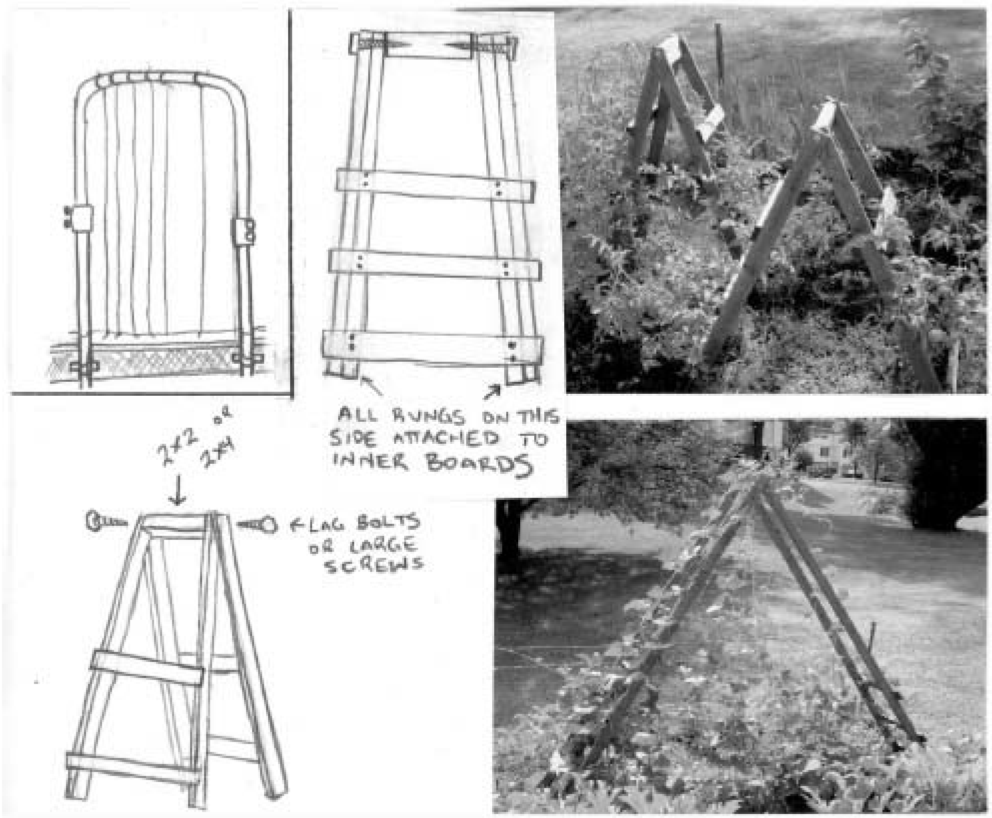
One way to make more room in your garden is to create ways for things to grow up rather than spreading out. Wooden stakes work for some tall plants, like sunflowers. Tomato cages keep tomatoes from sprawling out in the dirt.

My favorite innovation is metal arches. I'm still using the ones I made eight years ago. Buy four 8' lengths of metal conduit at the hardware store and ask them to bend two of them into 4' wide U shapes. Cut the remaining two in half. Use conduit connectors to attach the straight pieces to the curved pieces. You should have two 6' tall and 4' wide arches.

Choose a spot on the north side of your garden where you won't shade your other plants and bury the ends 6" to 12" in the ground. Attach them to the raised bed walls using conduit clamps.

Each year, tie a piece of twine tightly along the bottom of the arch, and string more lengths of twine vertically from that to the top of the arch. I tie one string for each plant—for tomatoes, one every foot, and for beans one every couple of inches. Beans climb right up the strings, whereas cucumbers and tomatoes sometimes need a helping hand as they grow.

For my mom, I built a sort of wooden ladder. It folds up in the off-season for easy storage. You can make your own from furring strips. They're inexpensive, rough cut pieces of wood about 1x2" and 8' long. Don't confuse them with the more expensive hardwood 1x2s. These should cost less than a dollar a piece.



To support beans, you'll want 8' ladders. For tomatoes, 4' is enough. Either way, start out with four equal lengths of wood. Attach two legs on each side of a 12" 2x2 or 2x4. This will be the apex of your ladder. Use lag bolts or screws to hold the ends together. Pre-drill so the boards don't split and the legs can rotate. Use washers between the boards to make things move a little easier.

The rungs can also be made from furring strips. The base of your ladder should be wider than the top, about 18" or 24". Start with that and then cut the rungs to get shorter as they go higher. Three on each side is usually enough.

Two final points:

First, grow what you're going to use. Think about what you actually eat, and plant that. It's a lot of fun to try new plants, but don't plant 20 heads of cabbage if you've never eaten much cabbage before. Try out a couple of heads,

and if you find you use them, plant more the next year. It's discouraging to have a dozen zucchini rotting on your counter, especially because zucchini take up 9 square feet for every plant or two.

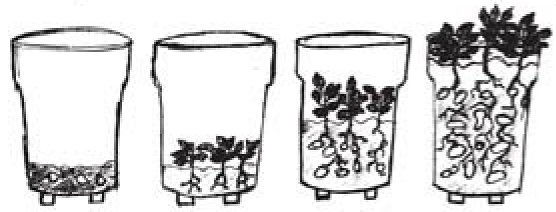
Second, consider the economic value of the harvest. Pumpkins take a long time to grow and use a lot of space, but can be bought cheaply. Tomato plants, on the other hand, will give you loads of organic tomatoes that would cost three or four dollars per pound at the store!

Here's a list of plants with the highest economic value based on pounds produced per square foot, length of time in the garden, and retail value.

- Tomatoes
- Onions (green and bulb)
- Leaf lettuce
- Turnip
- Summer squash
- Pea pods
- Beans
- Beets
- Carrots
- Cucumbers
- Peppers
- Broccoli
- Head lettuce
- Swiss chard

Low in economic value are things like melon, pumpkins, and corn. Plant these if you have room and want to experiment. But the high-value plants will make more of an impact on your pocketbook.

GARBAGE CAN POTATOES.



AT OUR OLD HOUSE WE DIDN'T HAVE MUCH OF A GARDEN, SO I WAS ALWAYS TRYING TO FIND WAYS TO STRETCH WHAT SPACE I HAD. ONE WAY I DID THAT WAS GROWING POTATOES IN GARBAGE CANS.

I GOT THREE 35 GALLON GARBAGE CANS FOR ABOUT $8 EACH & DRILLED ½ INCH HOLES IN THE BOTTOM FOR DRAINAGE. (IF YOU'RE EVER LOOKING FOR A CONTAINER AT MY PLACE YOU'LL FIND THAT ALMOST ALL MY BUCKETS AS WELL AS OTHER CONTAINERS HAVE HOLES IN THEM BECAUSE I'VE TRIED TO GROW THINGS IN THEM AT SOME POINT.)

I WENT TO THE COOP AND BOUGHT A FEW POTATOES OUT OF THE BULK BINS. I GOT A COUPLE EACH OF RED, BLUE AND GOLD. IF YOU'RE NOT PARTICULAR ABOUT THE TYPE OF POTATOES YOU WANT TO GROW, YOU CAN USE POTATOES YOU'VE KEPT TOO LONG THAT ARE STARTING TO GROW. ANOTHER PLACE TO LOOK FOR "SEED" POTATOES IS GROCERY STORE DUMPSTERS.

TO AID DRAINAGE I SET THE GARBAGE CANS ON SCRAP 2X4'S. THEN I PUT ABOUT A FOOT OF SOIL IN EACH ONE. YOU COULD JUST PUSH WHOLE POTATOES INTO THE DIRT, BUT IF YOU WANT MORE SEEDS, ALL YOU HAVE TO DO IS CUT UP THE POTATO. THAT'S WHAT I DID. I CUT THE POTATOES INTO CHUNKS, LEAVING AN EYE ON EACH CHUNK. THEN I LET THEM SIT

FOR A COUPLE DAYS UNTIL THE CUTS DEVELOPED A "SKIN." I PUSHED THESE INTO THE SOIL. ONE TYPE (COLOR) IN EACH CAN.

AS THE PLANTS GREW I WOULD ADD MORE SOIL IN THE GARBAGE CAN, ALWAYS MAKING SURE TO LEAVE AT LEAST A FEW INCHES OF PLANT ABOVE THE SOIL. (YOU CAN USE COMPOST INSTEAD OF SOIL IF YOU WANT, BUT I DIDN'T HAVE MUCH COMPOST.)

WHEN THE GARBAGE CANS WERE FULL OF SOIL, I PLANTED A FEW BUSH BEANS IN EACH GARBAGE CAN. THE BEANS PROTECT THE POTATOES FROM THE COLORADO POTATO BEETLE AND THE POTATOES PROTECT THE BEANS FROM THE MEXICAN BEAN BEETLE. (IF YOU WANT TO KNOW MORE ABOUT THIS, CHECK OUT THE COMPANION GARDENING ARTICLE.)

I PICKED THE BEANS LIKE I WOULD NORMALLY UNTIL THE POTATO PLANTS DIED. THEN I KICKED OVER THE CAN AND DUMPED OUT THE DIRT. I SIFTED THROUGH THE DIRT WITH A PITCH FORK AND FOUND A WHOLE MESS OF POTATOES!

I'VE HEARD PEOPLE DO THE SAME THING WITH OLD TIRES, STACKING THEM UP AND FILLING THEM WITH DIRT. THEY CLAIM THAT NO TOXINS ARE LEACHED INTO THE SOIL, BUT I DON'T TRUST THEM. YOU COULD GIVE OTHER LARGE STORAGE CONTAINERS A SHOT THOUGH. I ALWAYS SEE FOLKS THROWING THOSE THINGS OUT.

SAVE YOUR SEED

I grew up with a small garden, so I knew that you planted seeds to grow

things and that the things you grew produced more seeds. We planted apple seeds and beans. I know that every time an avocado came our way, we'd start the pit growing in a cup of water. Once we saved seeds from cantaloupe and planted them. When I started my own garden as an adult, it didn't take long until I was saving my own seeds.

I went to the co-op one day and there was a guy giving out samples of heirloom tomatoes. He explained that heirlooms were older varieties of seeds, many of which had been passed from generation to generation. Heirlooms often possess qualities that store-bought vegetables don't. I tried a couple different tomatoes and was very impressed with these little ones that were almost white. I bought a couple, figuring I would save the seeds from one of them to plant my own. This was before you could find heirloom and organic seeds in about any seed display. Your options were to save the seeds yourself or check out the Seed Savers Exchange organization that he told me about. Heirloom seeds go along with the idea of passing down stories, skills, bikes, or clothes.

Without knowing about the way seeds are "supposed" to be harvested and saved, I still managed to have pretty decent luck. I had a favorite type of tomato that I grew every year. I saved beans and peas. I experimented with planting seeds that I bought out of the bulk bins at the co-op. I saved some seeds from organic produce I bought at the co-op. I learned by trial and error.

The first time I tried to collect chamomile seeds, I was only getting the little flowers that form the center of the big flower. The seeds are underneath the tiny flowers. Echinacea is the same way. Sometimes I happened upon better ways by accident—like soaking tomato seeds—which I did because I was trying to keep the overripe tomatoes from rotting before I had a chance to get the seeds out.

As I started getting more interested in saving seeds, I started to realize even better reasons for saving them. Seeds that you save from your own garden are

gradually adapting to those specific conditions. By choosing seeds from plants that do well, you're choosing a plant that has adapted to your soil and climate and which will pass those traits along.

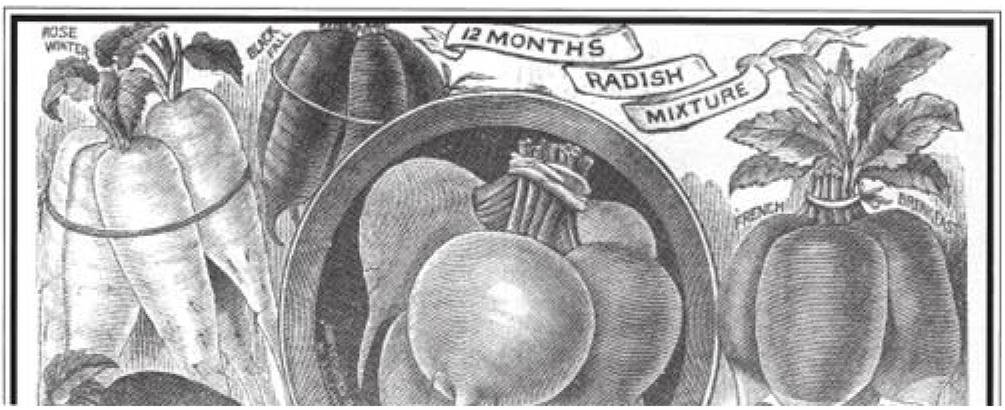
You choose the specific traits that you find important in a plant whether that would be a plant that gives fruit early, a plant that has large fruit, a plant that is tender or that has exemplary taste. I watched a show on dog breeding about how different breeds came to exist. Pit bulls looked very different a few decades ago but were bred for certain traits that people found desirable. As a result, the pit bull of today looks completely different. Vegetables are the same. You're doing this naturally by encouraging the traits that you like, rather than creating something completely different by splicing in new genes.

The seed business is a huge businesses and all human life depends on seeds. Without food, people die. Without seeds, there is no food. If you think the actions of Wal-Mart are despicable, compare it to the corporations who control the seed market. Five corporations control the global grain trade. Ten corporations own 32% of the commercial seed market. When you read that four companies control 79% of all bean seeds, or that five companies control 62% of flour milling, it may not jump off the page at you because our lives are full of that. You see the same chain stores and restaurants everywhere you go. Consider that all seed used to be controlled by individual farmers saving their own seeds, just like all Wal-Marts used to be locally owned, specialized shops. What used to be millions of farmers saving—and controlling—their own seeds is now a few big corporations. That puts the power in the hands of those seed companies. We're giving them the power of life and death.

But for those corporations, that is not enough. They have control of the commercial market but are fully aware that farmers in "third world" countries are not buying seed and saving their own. There may be generations of plant-breeding that developed plants that will grow and produce well in specific conditions. There are hundreds, if not thousands of varieties of a certain crop.

But commercial seed companies can't make money from farmers who collect and trade their own seeds. Their goal is to undercut farmers in "third world" countries by exporting cheap grain or produce into their country at prices they can't compete with. When locals buy the cheap import products it drives the small farmers out of business because they can't compete with the prices.

This starts a chain reaction, destroying the local economy and making it possible for agribusiness to move in. In order to compete, farmers try to grow grain as cheaply as big companies do. That's when these companies start espousing the benefits of monoculture and genetically modified crops.



They offer these farmers loans for seed, often for a variety that has been genetically modified for pest resistance. Conveniently, the same companies with a monopoly on the seed market also have a monopoly on the agrochemical and pesticide market. So when they sell farmers' seed that is not acclimated to their specific growing conditions, they can also sell them the chemicals it will need to grow.

One of the new "freedoms" we've given Iraq after "liberating" them is the ability to buy seed from transnational corporations. While Iraq was still reeling from the effects of the war, new laws were imposed with little or no input from the Iraqi people at all. The new laws ensure that Iraq has the same patent laws as the US, which were written by the World Trade Organization for the benefit of big business.

Seed saving will now be illegal in Iraq. Though the cultivation of grain was started in that area of the world, they are now forbidden from saving protected seeds. A protected seed is one that someone has registered and owns the rights to. Saving of these seeds is banned and royalties are to be paid when the seed is used. Previous Iraqi law prohibited private ownership of biological resources.

The laws made for Iraq may be even worse than the ones in the US because they make absolutely no provision for genetically modified seeds. They're treated as no different from traditional seeds. It's scary when genetically modified crops are unleashed on the U.S. It's scarier when they're unleashed on the cradle of civilization and the origin of grain cultivation.

Iraqis are allowed to save and grow traditional varieties—however—due to the lengthy war and sanctions, supplies of these traditional seeds are scarce, and transnational seed companies are more than happy to fill the gap. Traditional varieties can be genetically modified or otherwise manipulated and registered—making it illegal for Iraqis to save those seeds. The goal is to turn Iraq, an agriculturally self-sufficient exporter of produce, into a nation dependent on imports from agribusiness.

Another way of controlling the world's food supply is terminator crops. Since it is nearly impossible to prevent cross pollination between crops, the next logical step for seed companies is to produce crops with sterile seeds.

Officially known as genetic use restriction technology (Gurt), Terminator crops have DNA that kills the embryos so that the seeds are no longer living. The possibility of this trait being passed to other plants through cross pollination is pretty frightening, especially since there has never been any large scale testing. If the problem is widespread, it means everything dies, because everything relies on plant life. A variation on the terminator gene is the traitor gene: the plant will only grow correctly if the proper chemicals are used. If you don't use their proprietary chemical, the plant doesn't produce. If

you pay taxes in the U.S. you helped pay for 25% of the development cost of this technology. Although the seed companies are attempting to point out the benefits of this technology, there's only one real reason why the technology is being pushed. There is a lot of money to be made.

In some cases seed saving is already illegal. RiceTec, has patented a variety of basmati rice under the name Basmati. They're now attempting to patent a variety that has grown in India for centuries. What if Dodge took out a patent on a Ford truck and then forbade Ford to make any more of those trucks, or even use the name Ford? What if they patented something that occurred naturally?

In one case a third generation farmer who had saved seeds for 40 years had his crops contaminated by Monsanto crops grown in the neighbor's field. Instead of Monsanto being forced to pay for damages caused by their Genetically Engineered Roundup-crops cross-pollinating his, he was taken to court for "stealing" their technology and forbidden to save any more seed.

These companies have no interest in genetic diversity, so the only seeds they will continue to produce are the ones that make them the most money. Your delicious, tender tomato that you love so much can't be harvested and packed by machine, and it spoils too quickly to be transported across the country and sold at your grocery store. They focus their attention on the firm, thick-skinned tomatoes that store longer. They taste like a red tennis ball but genetic diversity doesn't make fruit that tastes good.

Genetic diversity also protects us against predators and diseases. The Irish potato famine was caused because almost all of the potatoes in Ireland were of one variety. When the potato blight came through, that variety was susceptible, and almost all the potatoes were ruined. Other types of potatoes grew that were resistant to the blight but too few were grown to make a difference.

In the U.S. we're setting ourselves up for such a calamity. Only four varieties of potatoes make up 75% of the potatoes grown. Two varieties of peas make up 96%. Only nine varieties of wheat are commercially grown in the U.S.

Many varieties of fruits, vegetables, and grains have already been lost due to the commercialization of the seed trade. 97% of reliable cultivated foods available in 1900 are gone. 86% of the 7,000 varieties of apples available just over 100 years ago are gone (Ann Cooper, *Bitter Harvest).* There are other varieties kept alive by only one person. There is a National Seed Storage Library that houses 400,000 seed specimens, but heirlooms and non-commercial varieties are generally ignored. It's a stockpile of commercial seeds that does nothing to protect biodiversity.

The mass marketing of seeds has eliminated localized fruits and vegetables and replaced them with seeds that can be grown en masse and sold all over the world, whether the plants actually fit that climate or not. I can buy many seeds in Minnesota that would have no chance of reaching maturity and producing more seeds. The only way to continue growing those crops is to continue buying expensive seed.

You may think seeds are cheap. They're usually discounted from the price marked on the packet: marked $2.49 and sold for $2.25 or $1.99. It doesn't seem like that much, but my organic yellow pear tomatoes were $2.49 for 200mg of seeds. One gram of seeds would cost $12.45 and more than half of what gold costs per ounce! Compare $5,647.23/pound for tomato seeds to anything else you buy by the pound. Perhaps this puts the effort of saving them into perspective.

There is one last and very good reason to save seed: because you can! There are many things in life that you can't practically do yourself. Chances are you can't make the pan that you cook your food in. Even if you make your own clothes, you probably don't make the fabric or the thread. You might be able to make your own plates, bowls and cups, but chances are, you didn't. It

would be near impossible to do absolutely everything yourself, and it's tough to decide which things you should attempt to do yourself. This is one of those things.

There is no great skill involved in saving seeds, and your life depends on seeds. Your life doesn't depend on plates, coffee, furniture, plumbing or bicycles, but it does depend on food.

HOW TO SAVE SEEDS

SELECTING PLANTS

There are general rules you want to follow when saving seed. You always want to choose the best plant and best fruit. "Best" may vary depending on what's most important to you. Some people will collect seeds based on taste. Many people will want plants that produce early so they'll save the seeds from the very first vegetable.

Some people will want the largest veggies. Selection encourages those behaviors. When you choose the healthiest plants, you are encouraging the traits that help it to grow well in your climate and soil. Saving seeds from plants that didn't do so well encourages traits that you do not want to encourage.

Seeds should only be collected from open pollinated (non-hybrid) plants. Hybrid plants are the spawn of at least two different varieties of plants, and when the seeds are saved they usually revert back to one or the other. If you save hybrid seeds, you will not get a true to type plant. Hybrid seeds are often sterile and won't germinate anyway.

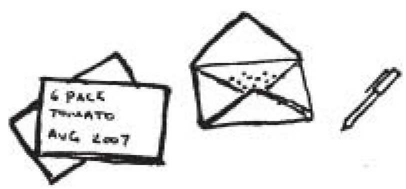
Open pollinated is kind of a misnomer, because many plants shouldn't be open pollinated. That is, some plants of the same family will be able to cross-pollinate and perhaps create strange crossbreeds.

In order for fruit or vegetable or seeds to develop, pollination must occur.

Plants such as peas and beans have perfect flowers which self-pollinate, sometimes before the flower even opens, and have little chance of cross pollination.

Plants such as squash have imperfect or incomplete flowers, which means that there are male and female flowers that are usually pollinated by bees, but can be hand-pollinated as well. With this type of flower, it is important that close relatives of the plant are grown at a sufficient distance to prevent one variety from pollinating another.

This is not necessarily important for plants which you intend to use for food, but it is important if you want to keep your variety of produce pure from other varieties. I've pointed out which plants are most susceptible this, so plan your garden accordingly.



PREPARATION & STORAGE

Seeds should be dried before they are stored. There are expensive machines that will test the moisture content of seeds, but you'll have to make your best guess. Little seeds will take less time to dry, larger ones will take longer. I usually try to keep them in a warm, dry place that is out of direct sunlight while they're drying. I like to put them on a paper plate and mark the plate with the date collected and what plant/variety the seeds are.

When your seeds are dry, you should label them for storage. I usually use small envelopes. There are instructions for making your own seed envelopes at the end of this article. If you're drying your seeds on labeled paper plates, transfer the information from the paper plate to an envelope.

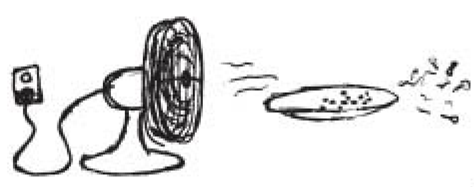
Curl the plate in half and slide the seeds into the envelope. Once the seeds are

in an envelope, the paper plate can be reused. Cross off or erase the old information and write the new info on there. I leave the envelopes unsealed or for large seeds, I sometimes use a bit of tape.

Seeds should always be stored in a cool, dry place. Fungi and bacteria thrive in moist conditions. That's why it's important to make sure your seeds are very dry before storing them. Fungi thrive at temperatures of 85 to 95 degrees Fahrenheit. Their growth is significantly slowed under 70 degrees, and under 50 degrees you basically don't have to worry about them at all.

A fridge or freezer is a good place to store seeds. Because of the fluctuating moisture in a fridge, the seeds should be stored in an airtight container—a jar could fit all of your seed envelopes in it. If you're still worried about excess moisture in your seeds, you can put some silica gel in the jar to absorb it. I normally keep my seeds in a box in the basement. It's pretty dry, and we run a dehumidifier down there to keep it that way.

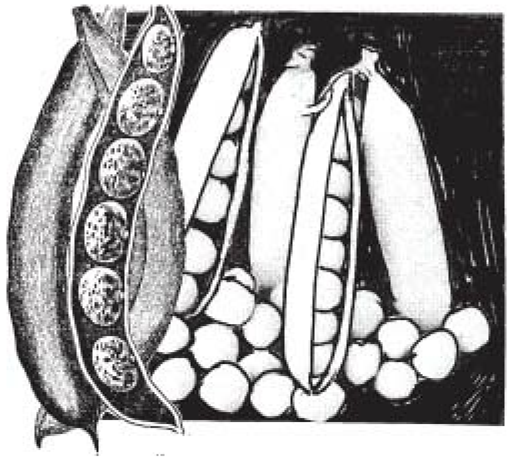
WINNOWING



Some seeds will have a lot of non-seed material mixed in with them after you've harvested them. Onion and hyssop come to mind right away. Sometimes I leave the plant material in with the seeds, since it doesn't seem to hurt anything. However, if you would like to remove the non-seed material, there is a pretty easy way to do it.

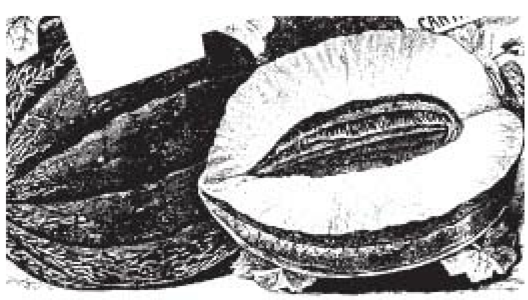
You can take the plate that you have your seeds on and hold it in front of a fan on the lowest setting. Even with tiny seeds like hyssop, the seeds will stay on the plate while the flower parts will be blown off. Another similar method is to put down a large piece of paper or cloth in front of the fan and sprinkle

the seeds onto it through the stream of air. Seeds will fall straight down onto the paper, but the chaff will be blown away.



BEANS & PEAS

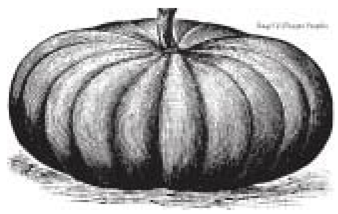
Beans and peas are probably the easiest seeds to save. You plant them like you would if you were growing them to eat. Don't plan to get them from the ones you're going to eat. Plant extras so you can collect the seeds from the earliest and best beans. Don't save the beans left hanging on the plant after you've taken about everything else as that that encourages late production. Once the beans are at about the stage you'd pick them for eating, you let it go for another month or so. Once they turn brown, pick them and bring them inside to dry for another 2-4 weeks. Seeds can be hand-shelled or flailed. Give them plenty of time to dry and don't store in airtight containers. Beans and peas greatly benefit from cool and dry storage.



MELONS

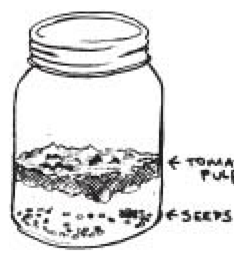
Another easy seed to save is melon seed. They are ready to save when the

melon is ready to eat, so you can eat the melon and set aside the seeds! Wash them and let them dry for some time before packaging. These seeds are prone to molding if stored too wet. They should be dried thoroughly.



SQUASH

Some squash are similar to melon—winter squash and pumpkin seeds are ready when the squash is ready for harvest. Summer squash (like zucchini) should be allowed to grow to full size before being harvested. In both cases you scoop out the seeds, wash them to remove all non-seed material, and dry before putting in storage. Squash will cross with some other squash, so if you're worried about it, grow only one variety.



TOMATOES

When you don't eat a ripe tomato fast enough and it starts to go bad, toss it in a jar with a little bit of water. Shake the jar until the tomato is all broken up, and let it sit. At first I did this to keep stinky tomatoes from leaking all over the counter, but this is also the correct method for saving tomato seeds. Let that mess ferment for a couple days. Shake it a bit every day to keep it from molding and to dislodge any more seeds. Good seeds sink to the bottom, while bad seeds and non-seed material floats to the top. Scoop out the stuff on top, and pour the remaining liquid through some cheesecloth or a paper towel to strain out the seeds. This also removes the coating on the tomato seeds, which is important. Let the seeds dry for a week or two and then put in

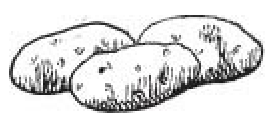
labeled envelopes. Tomatoes are self-pollinating, but some cross pollination can occur from insect activity. If you're very concerned about that, keep a good distance between varieties.

CUCUMBER

Cucumber only cross with other varieties of cucumber, so if you're only growing one type, it'll be fine. Allow cucumbers to become over-ripe. Let them turn yellow before you pick them. Scoop seeds out with a spoon, and ferment like you would tomato seeds.

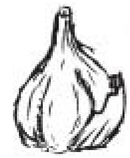
PEPPERS

Peppers are self-pollinating so there is little worry of crossing unless plants are very close. It is possible for bees to cross pollinate them, so to be dead sure it's best to plant varieties 100-650' apart. Some folks think that peppers should be allowed to over ripen a bit, until the skin starts to wrinkle. I've always harvested the seeds when I eat the pepper. Brush them out with your finger, and allow to dry; storing in labeled envelopes.



POTATO

Potatoes are normally grown by planting the tuber (potato) in the ground. I like to plant potatoes by putting a whole store-bought potato in the ground after it starts growing large eyes. You can also cut the potato up so each chunk has an eye, planting each of them. If you do this, the chunks should be allowed to season in the open air for a couple days so the cuts develop a "skin." Or you can set aside the small potatoes when you harvest and plant them the following year. This way you get to eat the large ones, and there seems to be no difference in production between planting large or small tubers.



GARLIC

Garlic is generally grown by splitting the cloves off of a bulb and replanting them. I plant a few cloves from garlic purchased at the store. Garlic produces bulbils, which are like tiny cloves of garlic that grow on top of the plant. You can grow garlic from these, but it may take two seasons to grow a full-size bulb, whereas planting a clove will yield a full-size bulb in one year. It's best if you cut off the bulbils when they start producing, so it doesn't rob the bulb of energy. If you do let them grow, they can be eaten like garlic. Bulbs will last 6-8 months.

ONION

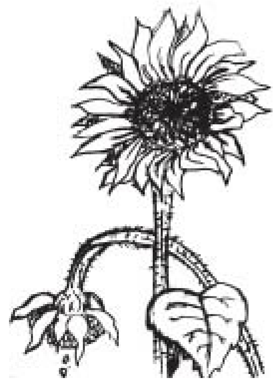
You'll have to plant extra onions if you want to save seed. Onions produce seed in the second year. People in harsh climates harvest and store onions over the winter and replant in the spring. In Minnesota I leave them in the ground all winter. However, this does preclude the option of removing onions with unwanted qualities. If you do harvest and replant your onions, plant only the best onions in the spring to promote those characteristics. In the second year the onion will send up a long thin shoot which develops a bulb on the end. It looks like a very small onion. This will open and turn into a flower called an umbel. When the umbel dries out and you can see a lot of black seeds in the tiny little capsules, cut the entire umbel off a couple inches down the stem. Let this sit for a few days to a couple weeks and then shake vigorously to get the seeds to fall out. I don't bother separating the seeds from the pieces of capsule that remain. Onion is pollinated by insects and will cross pollinate with most other varieties, so it is best to only grow one variety for seed each year. It's important to have a number of onions growing for seed to prevent inbreeding, which can produce unwanted traits. Onion seeds only last 1-2 years. When you see last year's onion or chive seeds on sale, pass them up; they often won't produce much of anything.

LETTUCE

Lettuce is one of my favorite plants for “letting nature do what nature does.” We plant lettuce every year, mostly leaf lettuce. When we eat it we seldom pull up a whole plant, we go out and take off some leaves from a few different varieties and let it keep growing. When the weather turns hot, they start to send up seed stalks. The seed stalks grow right out of the center of the lettuce, and have little buds on them. When they start to come up, I pull the ones that bolted the earliest. The ones that bolted later, I let go to seed. The buds open up into little flowers, which then mature into seed. You know the seeds in a flower are ready when they turn furry like a tiny dandelion. However, lettuce flowers all mature at different rates, so you can’t take the whole thing in when it’s all mature. Let them sit out there for a while. Like dandelions those little seeds find their way back into the garden as was all as over the yard. When there are a number of seeds that are mature, cut off the whole top and put it in a paper bag. Let it dry out for a day or two and then shake all the seeds out. Those seeds that floated down all over your garden? They won’t sprout while it’s hot, but as soon as it warms up again in the spring, they’ll start volunteering all over your garden, and perhaps in your yard too. Occasionally a late frost will take them by surprise, but for the most part, you can let them grow. It’ll be one of the first things you get to eat out of your garden. When it warms up enough to start putting other things in your garden, pull up the lettuce in your way and eat it.

SPINACH

Spinach has male and female plants, and you’ll need some of both to grow seeds. Plant a whole bunch. The male plant will flower, the female will produce seeds. To remove the seeds, wrap a gloved hand around the bottom of the seed stalk and run your hand up the stalk, stripping the leaves and seeds. Once the seeds are dry they can be winnowed and stored. Spinach is wind-pollinated and the pollen is very fine, so it’s best to only grow one variety.



SUNFLOWER

Somewhere there is a picture of me as a kid sitting on my BMX in front of my sunflowers. Apparently, my interests haven't changed much. With sunflowers you let them grow until the center is completely filled with seeds and the petals have fallen off. Then you cut off the head and put it somewhere to dry. You want to protect it from birds who will steal your seeds, and it should be out of the sun anyway. The seeds are removed from the head when they are no longer soft. Pull out by hand but be warned that it's very time consuming. Alternatively, put a piece of 1x1" hardware cloth over the top of a 5 gallon bucket, and rub the head back and forth across it. Seeds will need additional time to dry. They're ready for storage when they snap in half when bent. If they still bend, they should be dried longer. Sunflowers should be kept ½ to 3 miles away from other varieties. Sunflowers can be self-incompatible, so always grow a few. Seeds can stay good for 7 years when stored properly!

HORSERADISH

DO NOT PLANT HORSERADISH! Now, let me finish, don't plant horseradish anywhere you don't want it next year and every following year. It will also spread like crazy! It spreads by root division, which means that any piece of root in the soil will grow a new plant the following year, and it sends out very long roots. My wife bought a plant and put it in my garden a few years ago. It sends up plants all over the 4x5' section of the garden she put it in. The only reason it didn't take over the other side too is because a board separates the halves. Seed saving with horseradish is really root saving. Dig up the root, cut it into 4-6" long sections and replant.

RHUBARB

Rhubarb can be grown from seed, but it is best to propagate by crown division instead. This ensures that new plants grow true to type, as well as making room for the “mother” plant. Dig up the plant early in the spring, cut off several small sections of the crown and replant both the “mother” plant and the new sections. If you want to plant from seed, allow the tall center stalk to grow. When the seeds turn brown and dry, cut off the whole top of the stalk. Rhubarb does not necessarily reproduce true to type, so if you’re growing from seed, plant at least 20 and select the best ones.

CORN

Corn is one of the main monocultures in America, which could be a great reason to save quality seed. For saving corn seeds, it should be 1000’ from any other variety. It’s pollinated by wind, so it’s very easy for cross pollination to occur. Ears should be left on for a month after the rest are harvested for eating. Leave the best ears for seed saving and eat the rest. Husks should be pulled back and the ears hung until the kernels are dry. Once dry they can be removed and stored. Corn seeds last 1-2 years.

CARROTS

Like onion, carrots are a biennial, meaning it only produces seed in the second year. To save seeds, plant and harvest like you would for eating. Save the best carrots for seed. Store inside over the first winter in a cold and humid place. Many people like to store them in damp sand. Replant the following spring. Seeds are ready for harvest when heads have turned brown. Dry until brittle and then rub to free the seed. Only one seed variety should be grown each year. You can still grow other varieties that aren’t seeding at the same time. Carrot seeds last 3-4 years.

RADISH

Plant and harvest as if for eating. Keep the best ones for replanting. Cut off all but 1” of leaves and replant with the crown at ground level. Give twice as much room for seed plants. I’ve only ever done these by leaving them in the ground: let nature do what nature does. However, this does eliminate the

chance to pick out the best radishes to use for producing seed. Whether you replant or let them grow, they'll eventually develop a seed stalk with pods on it. Leave it until most of the pods are brown. They'll need to be opened by hand. Seeds will be light- colored at first, but will turn a more recognizable brown in storage. It will cross with Chinese cabbage, rutabagas, and mustards, so only one should be grown at a time. Seeds should last 4-5 years when stored correctly.

BROCCOLI

The part of broccoli that you eat is actually the start of flowers, and if you let it grow too long it'll start sending up shoots with yellow flowers. Those shoots will develop seed pods. As those seed pods dry, they crack open and drop their seeds. The problem is they don't all develop and dry at the same time. So when there was a lot of good-sized pods and some of them were starting to dry, I cut the whole plant off just above the soil, tied a bit of twine around the stalk and hung them upside down to dry with a piece of cloth to catch seeds that fell. When the whole thing was dry, I stuffed it into a brown paper bag and broke off the stalk at the bottom. Then I gave the bag a good thrashing and then walked on it. When I opened the bag, most of the seeds had fallen out. I poured the contents of the bag onto my fabric, then it was easy to pick out the big pieces of the plant and seed pods. I winnowed a small portion of it by pouring it from hand to hand while I blew through it. I saved the rest of it in a small lunch bag to separate later. Broccoli will cross with brussels sprouts, cabbage, cauliflower, collards, kale and kohlrabi. Seeds will last 4-5 years.

CABBAGE

Being a member of the same family as broccoli, it has similar pods, but that's where the similarity ends. Cabbage is a biennial. So you have to dig up a few nice, firm heads with roots and cut off the outer leaves. Store it wrapped in newspaper with the roots in damp sawdust at 32-40 degrees at high humidity (80-90%) for the winter. Put them back in the garden in the spring, cutting a shallow in the top of the head. This allows the seed stalk to push through more easily. When the seed pods have turned dry and brown, you can pull

them off and harvest the seed. They won't all mature at the same time, and seed pods harvested before they turn brown generally do not produce viable seed. Another trick is that it's often self-incompatible, meaning that the pollen from a plant will only work on another plant—it can't pollinate itself. The pollen from one plant must be transferred to another plant. Usually insects take care of this, but it's best to grow at least 6 heads of cabbage if you're growing it for seed, to make sure you have sufficient diversity. Cabbage will cross with the same things as broccoli. Seeds are good for about 4 years.

HERBS

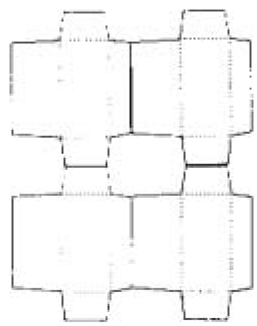
I can't think of one herb that doesn't flower, and flowers are pretty easy to figure out. A flower is a plant's way of attracting pollinators like bees and butterflies. Seeds are going to come from the flower but they'll look different from flower to flower. Here's a few of the herbs we collect seeds from at our house.

CHAMOMILE

Chamomile seeds are ready to be harvested when the pedals fall off the flowers and turn brown. If you pull off a couple brown flowers and started rubbing them, a bunch of little things come out that resemble seeds, but are not. Look closely at a chamomile flower and you'll see that the center section is made up of what looks like tons of little flowers. The seeds are under those tiny flowers. Wait until those little flowers fall out on their own. What's left is a brown half sphere that has little "hairs" sticking out.

MAKE YOUR OWN SEED PACKETS

If you're all about doing it yourself, rather than using store-bought envelopes, you can make your own seed packets, I designed this one so that 4 will fit on one 8.5x11" piece of paper with very little waste. Make 4 copies of the template below and paste them onto a piece of paper. (Copy at about 110% for a perfect fit,) Use that as your original and make copies as needed .

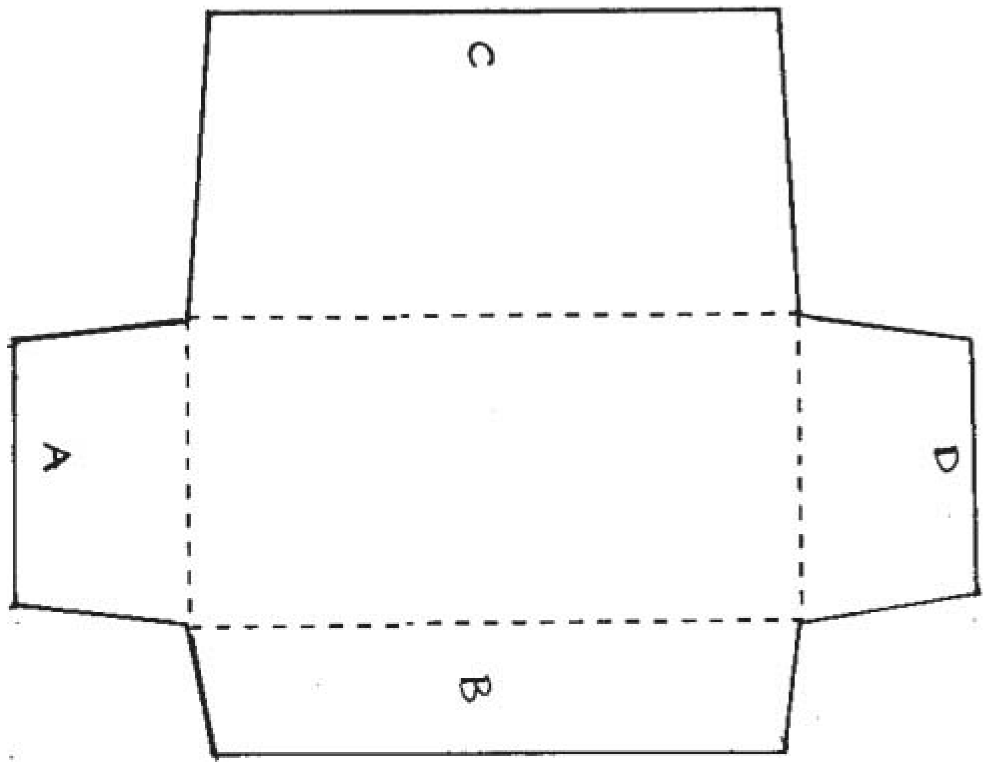


To make the seed packet:

1. cut out the template
2. fold along dotted lines
3. fold tab A in firsts and put some glue on it (glue sticks work best)
4. fold tab B over tab A
5. put a line of glue all the way down tab B
6. fold tab C over tabs A & B

Label them with plant type & date and put your seeds in them. The top flap (D) can be sealed with glue or tape

If you need bigger packets for larger seeds, copy the template at 137% and two will fit on one page.



The seeds are down inside those hairs. Put down a piece of paper and rub your finger back and forth across the flower, the seeds will fall out on the paper. Alternately, rub two flowers together.

ECHINACEA
(Purple Coneflower)
Echinacea is similar to chamomile for collecting seeds. The seeds are ready when the flowers turn brown and very dry. The hairs that protect the seeds are more like spikes, so avoid pressing directly on them. Try to rub from one side. Use a decent amount of pressure, and they should come out in groups. A piece of paper underneath will do a good job of catching your seeds. Echinacea will germinate better if subjected to freezing temperatures for a few weeks.

HYSSOP
I haven't figured out an "easy" way to collect the seeds from hyssop. It's more labor-intensive than other seeds. Bunches of small purple flowers develop near the top of the stock, which bees seem to love! When the base of the

flower turns brown, you can pull it off and you'll find usually two small black seeds inside. I wait until all the flowers are gone and then cut off the whole stalk and bring it inside to collect the seeds.

MINT

When mint goes to seed, it develops a bunch of tiny little purple flowers at the top of the plant. Inside those tiny purple flowers are even tinier black seeds. I usually wait until the flowers start drying out and then shake the plant upside down into my hand, or onto a piece of paper.

Once you start saving seeds, it becomes second nature. I've covered plants that are popular garden plants. You'll soon figure out how to harvest seeds from plants not covered, only by thinking about how seeds are produced and taking a close look at your plant.

Biennials might throw you for a bit of a loop, but if you check your local library you'll find books entirely devoted to seed saving that will give you details on how to save seeds from a wide variety of plants.

SEED STARTING

Starting seeds in the garden is a fairly simple process that needs little explanation, so this piece is more about starting seeds indoors. Growing plants indoors needs a bit of explanation because it doesn't work exactly how you might expect.

The main reason to start your seedlings indoors is because you live in a colder climate and have a relatively short growing season. In Minnesota the last frost date according to the *Farmer's Almanac* is May 5th.

In order to get the most produce from my garden, it's best if I put plants in my garden after May 5th instead of starting with seeds at that time. Plants started at the beginning of March have an eight week head start. Some vegetables take so long to grow that they wouldn't have enough time in a

short growing season.

Every year I start a bunch of plants from seed and also pick up a few tomato or pepper plants. I get the six packs of plants and give half to my mom for mother's day. Each little six packs costs about $1.50-$2.50. Slightly larger plants in single containers usually run about $1.50.

Last year I picked up half a dozen of those six packs and a couple individual plants. That cost $12-18 on plants. That could have bought 14 packets of seeds, which would have contained anywhere from 20 seeds each (tomatoes) to 300 seeds (onions). That's the difference between 38 plants and 280-4,200 plants!

Twelve plants ended up being so badly infested with aphids that I didn't even put them in my garden, so it was only 26 plants.

Starting seeds indoors still requires a little bit of cash expenditure. My first year cost me less than $10, including 2 bags of soil, a bag of 50 jiffy strips (biodegradable plants pots that you can put directly into the ground) and hooks for hanging my lights. Everything else was reused, dumpstered or otherwise salvaged!

I posted a wanted ad on Twin Cities Freecycle for florescent lights and someone gave me four 4' lights and a 2' light. I had a bunch of little yogurt containers I started seedlings in years ago, as well as a bunch of small plastic pots that someone threw away.

I used scrap wood and household waste for flats. I spent another $6 on 2 timers so I wouldn't have to remember to turn the lights on and off, bringing my total expenses still under $15; still less than I might spend on plants in one year.

I'm not really sure how many people buy plants exclusively. It seems so

expensive, and we're all about doing it ourselves and avoiding consumption and the exchange of currency as much as possible. If there are folks reading this who garden exclusively from purchased plants, here's one more reason to start your own seedlings: the selection of plants is rather limited.

I go to a plant sale at our co-op every year, and they have some heirloom plants available and a slightly larger variety of unusual vegetables and herbs. However, many folks don't have that luxury and a regular or seasonal nursery set-up at a big box grocery or department store is going to have a very limited selection. You'll choose between 3 or 4 varieties of fist-sized, round, red, hamburger tomatoes. If you're looking for peppers you'll most likely find green and red bell peppers, but they are probably the same pepper at different ripeness, and jalapenos.

The tomatoes I fm growing this year are: Mortgage Lifter, Cherokee Purple, Black Krim, Black from Tula, Pineapple, Italian Black Plum, Garden Peach, Old Brooks Pink Oxheart, Golden Girl, Black Seaman, Subarctic Plenty, Italian paste, Gardeners Delight, Red Pear, and "6 pack" tomatoes. I saved seeds for Garden Peach and Golden Girl that I could still plant too!

It'd be next to impossible to track down any of those as plants. Each of them is a unique variety that I chose for specific characteristics. When choosing from plants, you don't have much to choose from.

For me it's a combination of wanting to get a head start with varieties that I can't find elsewhere. I'm looking forward to sharing my seedlings with friends and family. I wasn't that impressed with the Golden Girl tomatoes, but my sister was and told my mom, "I hope Matte gets us those same tomatoes again this year."

Do you need to know what a seed is? It's a plant embryo. Inside the seed coat, which protects the parts inside, lies a tiny dormant plant and food source (endosperm) that the plant uses during dormancy and germination.

Sometimes cotyledons, the first simple leaves that come from a seed, store the carbohydrates, fat and protein.

The embryo consists of one or two cotyledons, a root tip and a tiny bud. The embryo will stay dormant until the right conditions come. In order for a seed to germinate, it must receive the proper combination of moisture, temperature, light and air. This combination is different for every seed.

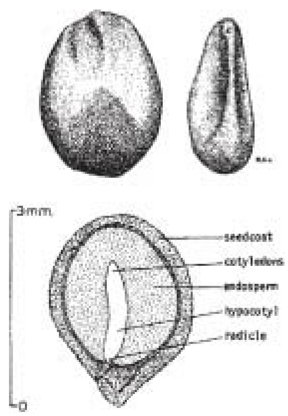


Image provided by USDA

Most plants will germinate between 75 and 90 degrees, so that's a pretty safe bet. But lettuce and onions, for example, can germinate at 35 degrees Fahrenheit. However, an onion seed at 41 degrees will take 30 days to emerge, whereas an onion seed at 77 degrees will take 3 days.

The plants won't go anywhere without moisture. Seeds also need air, so if the soil is constantly soggy with water they will rot in the ground. Most seeds don't need light to germinate and the ones that do, we consider weeds. Once these conditions are met, the seed coat breaks open, the root grows, and the cotyledons push through the surface to start the top of the plant.

So how do you meet those conditions in your house? And once those conditions have been met and you've got seedlings, how do you keep them healthy and strong until it's time to transplant them in the garden?

You're going to need containers. Pretty much anything about the right depth that can hold soil will work. I've done quite a bit of experimenting to see what works well. I've used small plastic yogurt containers, half gallon rice milk containers cut in half lengthwise, quart-size rice milk containers with one side cut off, margarine tubs, vegan ice cream containers, food cans, peat pellets, peat pots, plastic pots, pots made from cardstock, pots made from newspaper, plastic cups and wooden flats.

The main criteria is that it should be about 3 to 3.5" deep and allow excess water to drain. 3" allows enough room for the roots to grow and ensures that the soil doesn't dry out too quickly. Anything over 3.5" uses more soil or seed-starting medium and serves no purpose.

I like the little yogurt containers. I put 3 holes in the bottom of each one, fill them with seed starting medium and put a seed in it. I saved them from a long time ago when we ate little containers of yogurt. You can reuse whatever you have available. Plastic cups work just as well, but won't last as long.

An easy way to put holes in them is to heat up the tip of a wire hanger and push it through a stack of about 10 cups. If you are quick you can make 4 holes through each stack before the hanger cools.

For cardboard pots cut a strip of cardstock 4” wide and 8.5” long. Roll into a cylinder and put a staple at the top and another about an inch from the bottom. Cut 1” slits about every 3/4” around the bottom. Fold these up to make the bottom of the pot.

Once you get a bit of soil in them, they sit fine. You can make some with the leftover 3” strip (to get a third pot out of each sheet). Don’t cut slits in for the bottom and instead stick a piece of newspaper inside. I used these for transplanting seedlings out of my flats. You can use a marker to write the plant info on the side. However, the longer the plants are in the cardboard pots the worse they look. So transfer when necessary. You’ll be tempted to use toilet paper tubes, but I’d advice against it. When they get wet, the glue dissolves and the tube falls apart.

NEWSPAPER POTS

CALLING THESE 'POTS' MIGHT BE TAKING IT TOO FAR. BUT THE CALL THOSE PEAT DISCS THAT SWELL UP IN WATER 'PEAT POTS' SO I THINK I'M ALRIGHT. THESE ARE REALLY JUST FOR STARTING SEEDS. THEY'RE HANDY BECAUSE YOU CAN PUT THE WHOLE 'POT' DIRECTLY INTO THE GARDEN, AND CHANCES ARE YOU HAVE SOME KIND OF NEWSPAPER IN YOUR HOUSE. PLUS THEY'RE SUPER EASY TO MAKE.

JUST FIND SOMETHING SMALL AND ROUND (I USED A BOTTLE OF NATURAL COUGH SYRUP) TO WRAP THE NEWSPAPER AROUND. MY

BOTTLE HAD A DIAMETER OF 1.5 INCHES. I CUT STRIPS OF NEWSPAPER 2.5-3 INCHES WIDE & LONG ENOUGH TO WRAP AROUND THE BOTTLE TWICE. I ORIGINALLY DID THESE WITH DRY NEWSPAPER, BUT FOUND IT WORKED A LOT BETTER IF I WET THE STRIPS OF PAPER FIRST. OTHERWISE THEY TEND TO COME UNDONE BEFORE YOU CAN GET THE SOIL IN THEM. WRAP THE PAPER AROUND THE BOTTLE SO ABOUT ONE INCH HANGS OVER THE BOTOM. ONCE THE WHOLE STRIP HAS BEEN WRAPPED AROUND, FOLD THE PAPER OVER THE BOTTOM. (IF YOU'RE USING DRY PAPER, YOU'LL HAVE TO PRESS THE BOTTLE DOWN ON A HARD SURFACE WITH A TWISTING MOTION TO CREASE IT) THEN JUST SLIDE IT OFF THE BOTTLE. I MAKE UP A BUNCH AT A TIME AND PUT THEM IN AN OLD CAKE PAN. FILL EACH TO ABOUT 1/4-1/2 INCH FROM THE TOP WITH SOIL. PLANT ONE SEED IN EACH POT AND WATER. I USUALLY WATER FROM THE TOP THE FIRST TIME. AFTER THAT I JUST POUR WATER INTO THE PAN AND LET THE POTS SOAK IT UP. ONCE YOUR SEEDLINGS ARE THE SIZE YOU WANT, YOU CAN "TRANSPLANT" THE POT AND EVERYTHING RIGHT INTO YOUR GARDEN. IF YOU LEAVE THAT HALF INCH OF PAPER AT THE TOP STICKING OUT OF THE SOIL, IT WILL HELP PREVENT CUTWORMS.

A couple BIY (Buy It Yourself) options are peat pots and peat pellets. Peat pellets are made of compressed peat moss. You get them wet and they slowly

expand into a little self-contained cylinder of growing media. You plant a seed in the top and when it comes time to transplant, you put the whole thing in the ground. Peat pots are very similar. They're little pots made out of compressed peat moss. You fill them up with seed-starting medium, plant a seed, and when it's time to transplant you can put the whole thing in the ground. The pellets run about $2/ bag of 25 and the pots run about the same for 5 strips of 10 pots.

I used pellets previously, but tried pots this year. Both work great! They are good for plants that don't like to be transplanted as are paper and cardboard pots. They're handy if you're running behind and want to get your seedlings started in a hurry. They work best with the matching plastic tray. One pack of peat pots will fit perfectly in one plastic tray, which is pretty nice.

Peat pots do tend to dry out rather quickly though. I've killed seedlings because I got busy one day and didn't check my plants until the next day, when they were already dead.

I set most of my containers in cake pans or cookie sheets. They are easy to move around and water. Pour water into the pan and let it soak up from the bottom. Top watering can dislodge the seeds and damage young plants. To make sure that the top of the soil stays wet until the seeds sprout, I wet it with a mister. Use the kind of sprayer that window washing liquid comes in!

Flats are another option. They are a shallow box. Grocery stores get berries and stuff in small wooden boxes which work well as growing flats. If you can't find any, make one! I had a piece of ½" plywood leftover from my soda can solar panel. It was about 56" long and 3.5" wide. It divided up perfectly for a 12x16" box. So I cut two 16" lengths and two 12".

I picked up a jar of ring shank nails at an estate sale. They are the nails with raised rings around them so they don't pull out as easily. Standard nails may pull out too quickly with the moisture from the soil causing the wood to swell.

Once the box sides were assembled, I took a few pieces of lathe and laid them across the bottom lengthwise.

I marked and cut them to length. Then I nailed them to the bottom leaving about ¼” between slats. To make sure they stayed in place I cut a couple scraps of lathe to 12” long and nailed them over the ends of the lathe slats. Aside from keeping the slats on a little better, they also act like feet to keep the flat off the counter.

Flats are nice for planting a whole mess of seeds in a small space and then transplanting them into containers later. Some folks suggest scattering your seed over the surface of a flat, but you’re seldom going to want that many of one plant and would have to thin them out later and waste seeds.

Plant seeds in rows like the flat was a miniature garden. I mark the end of the rows with what I planted and when. When the seedlings are large enough I plant them in bigger pots. This saves room under your lights and is a smaller area to heat if you need to keep your soil warm.

One thing to keep in mind when doing it this way is to plant seeds that will grow at about the same rate. If you plant squash and tomato at the same time, you’ll find that the squash are touching the lights while the tomato seedlings are still tiny. So the lights will either be too close to the squash or too far from the tomatoes.

You’re going to need some seed-starting medium. Just about every book you look at will tell you not to use garden soil. But when I start seeds outside, I plant directly in the garden soil and they grow! I’ve used soil directly from my garden to start seeds indoors.

This year I tried a couple other things to compare. I bought seed starting mix and potting soil. I made sure neither had chemical fertilizer in them. The potting soil was $1.66 for 40 pounds and the seed starting mix was $4 for 10 dry quarts, significantly more expensive.

Seed-starting mix is looser, lighter, a little easier to work with, and holds moisture better. Potting soil isn't terrible though. If you use potting soil, add some compost to it. Or use a mix of garden soil and compost.

Other books tell you not to use garden soil because it may contain weed seeds, insects, disease, and fungi. They suggest baking garden soil for 30 minutes at 180 degrees Fahrenheit to sterilize it. Bear in mind, this would smell terrible.

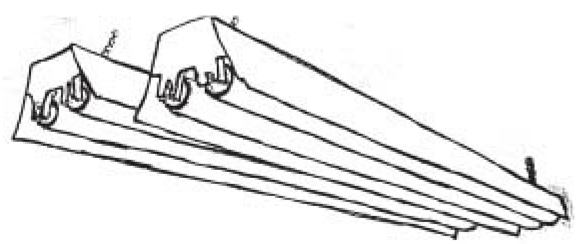
Seeds manage to germinate in the wild without a seed starting mix and similarly you can do the same thing at home. But if you're having trouble with your soil crusting over or with keeping your plants alive, you might want to consider sterilizing your soil or buying seed starting mix because your soil may be the problem.

The next thing you're going to need is a warm place to put your flats or containers. Most seeds don't need light to germinate, but germinate best when the soil is at least 70 degrees. When the ambient air temperature is 70 degrees, your soil is actually cooler because evaporation cools the soil. If you have radiant heat, put your seed flats on top of the radiators.

Christmas lights produce a bit of heat, and since there are about 100 lights on a string, they can be spread around to heat more evenly. You probably have some tucked away in storage somewhere; otherwise they're easily available at the Goodwill. Spread them out on the counter and put the flats and trays on top of them. Seed flats without heat can take more than three times longer to start popping up. Other options for heat might include on top of a water heater or a fridge.

The seeds only need heat until they germinate. After that they should be moved and new flats can be set on the heat. Some studies demonstrate that seedlings grown in cooler temperatures tend to set more fruit. Cooler temperatures partially compensate for a lack of light, keeping the plants from getting too spindly. However, the heat will help them germinate more quickly.

Of course seeds need water to germinate. Your soil should stay moist, but not sopping wet. Seeds need air to germinate and if the soil is always soggy they'll rot. When you first plant your seeds, it can be helpful to cover your flats with a plastic bag. This should hold in enough moisture that you won't have to water your flat again until the seeds start to sprout. You can also buy plastic trays with clear lids.



If you notice mold growing, you have too much moisture and not enough air. Remove the cover until the problem clears up. I've used plastic at times, but mostly I just check once each day and make sure the soil is moist in all containers. Soil on heat dries out pretty quickly, so I usually water them every day. Whenever possible water from the bottom.

Most seeds don't need light to germinate, but there are exceptions like lettuce, dill, flowers, herbs, and weeds. And once any seed has sprouted, it needs light right away! Seedlings have the highest light requirements of all plants. They should get at least 12 hours of light each day but 16 is even better! They shouldn't get more than 18 hours. If they get too little, they will grow thin and tall reaching for the light.

It's tough to give your plants enough natural light, especially if you're growing them to get a jump start on a short season. If you have a very bright south-facing window, you can give that a shot. Make sure to turn the plants daily to keep them growing straight, because they'll lean toward the window to get sun. Lacking a bright window you could buy, borrow or salvage florescent lights.

If your memory is fuzzy or you are unpredictably busy, you can use timers. I used a homemade 4 plug extension cord to plug in two florescent lights, my Christmas lights, and an extension cord going to two more florescent lights. Everything could be plugged into one timer, and they all go on and off at the same time. Having them turn on at 8 AM and off at midnight gives you 16 hours.

Your lights will need to be suspended above your plants, and preferably adjustable. Some cup hooks under a cupboard work well. Hooks on the ceiling over a tall shelf with your plants on it works well too. When I needed more room for seedlings, I made a rack to suspend my lights from out of an old TV cart. That way the plants could be on the basement floor. If you hang the lights with chains, they can be easily raised and lowered. As the plants grow, move the chain up a link or two. The lights need to be close to the plants, but not touching. They should remain about 3" away from the top of the leaves.

You may be inclined to try other lights, but florescent are really the best. You don't need special growing lights; any normal florescent light will work fine.

Incandescent lights are too hot. They are really small heaters that shed a bit of light as “waste.” You might be tempted to use sun lamps but you’d find out that all the extra UV light wouldn’t be good for your plants. Florescent are closer than any other artificial light to full spectrum. And if that wasn’t enough, florescent lights use electricity more efficiently.

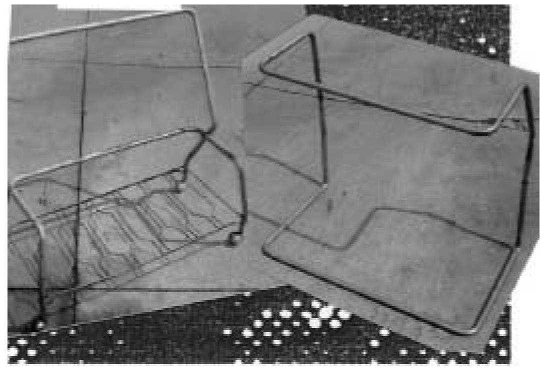
Florescent lights are long enough to fit a lot of plants under them too. A double row of tubes is enough for 16” wide flats. Two double rows are even better. The light at the ends of the tube is weaker than in the middle so buy the longest bulbs you can. Rotate your flats from middle to ends so the plants take turns getting the best light.

You might want to add a fan to your setup. Air circulation helps prevent mold from growing on your soil.

How to get the most out of your lights

- Don't turn your lights on and off a lot. This makes the tubes last longer.
- If possible put your growing lights where you need light anyway. Mine are in the laundry room in the basement so oftentimes when I go in there I don't need to turn any other lights on.
- Putting white or reflective material near the lights and flats helps get more light to the plants.

Air moving over the plants helps them to grow stockier. My sister says you can brush your hands over the seedlings a couple times each day to accomplish about the same thing. The idea is that both stress the plant a little bit and cause it to grow stronger rather than taller.



When it's time to plant the seeds, water the soil first. This prevents accidentally dislodging the seed by watering it directly after planting. When planting large or very hard seeds, soak them first to speed up germination. You can also do this when planting seeds like beans or peas directly in the garden.

When planting, put the seed directly on top of the soil. Place the whole row, and then go back and push the seed into the soil. For small seeds like tomato, use the tip of a chopstick to put it into the soil, and then brush a bit of soil

over it with your finger. Large seeds should be a planted a little bit deeper than small seeds, but no more than ¼” deep. Small seeds should be barely under the surface of the soil.

TRANSPLANTING

If you plant your seeds in individual containers, it’s not really necessary to transplant them until moving them into the garden. Plants started in flats will usually get crowded and need to be transplanted into individual pots before going out into the garden. Transplant when the seedlings get their first true leaves. The first “leaves” are actually the cotyledons that store food the plant uses until it produces true leaves.

Before you start transplanting, water the seedlings. This will help soil stick to the roots and prevent shock to the plant. Then gather up containers to put your seedlings into. If you’re using homemade newspaper or cardboard pots, have a bunch made before you start. Label the new containers. If there’s nowhere to write, insert a popsicle stick or you can make labels by cutting strips from a plastic bottle.

You’ll want some sort of tool to remove the seedlings. Don’t grab them by the stem and pull! I use a letter opener, or a popsicle stick. A spoon handle or fork work well too. Push into the soil next to the plant and pry it up while holding onto the leaves. You don’t want to hold onto the stem because if you crush, fold or twist it, the plant will die. A damaged leaf will be replaced.

Fill the containers halfway full of soil. Then hold the plant so the bottom of

the roots are touching the soil. Then fill soil around the roots. After all the seedlings are transplanted, give them some water and put them under the lights.

Some plants should not be planted in flats because they don't do well when transplanted. These plants should either be planted in individual pots or seeded directly into the garden:
- squash (including pumpkins)
- melons
- most root crops (carrots, turnips, beets, radishes, etc.)
- cucumbers
- beans
- dill
- fennel
- parsley
- spinach
- pea
- corn
- Chinese cabbage

Beans do well when planted directly into the garden. Radishes grow so quickly when seeded directly it seems a waste of time to start them indoors.

Squash has a rather extensive root system even before the leaves pop through the soil. Chinese cabbage doesn't start out as quickly, but still has quite the extensive root system when compared to other plants from the cabbage family. Disturbing such an extensive root system stunts the growth.

Seed-starting mix has very few nutrients in it, so to make sure the plants got enough "food" water them with compost tea or put some of the vermicompost on top of the soil. Sifted compost will work too. You can avoid top dressing by putting some in the mix from the start.

TRANSPLANTING YOUR GARDEN

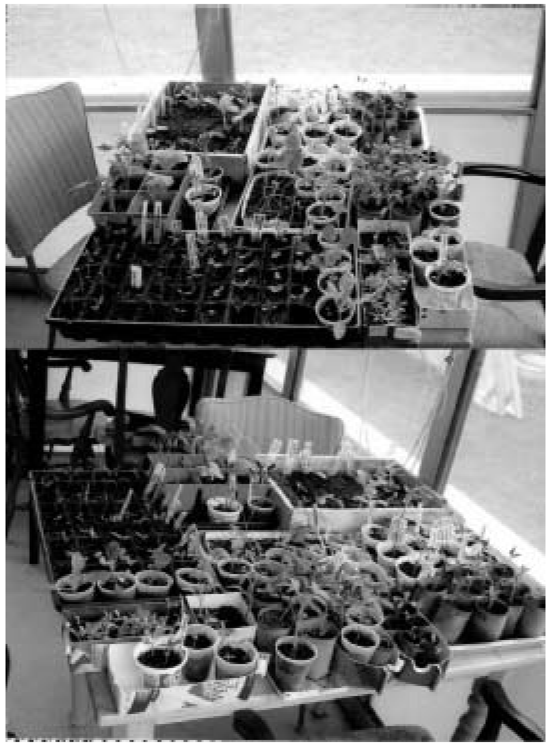
The first thing you need to be aware of before putting plants into your garden is the weather. Check the *Farmer's Almanac* to find out when the "last frost" date is. For me it's May 5th. That means that by May 5th you are relatively safe to put your plants out. You still need to pay attention to the weather. If you're still getting hard freezes on May 1st, you probably want to wait a while longer before putting your plants out.

You also need to pay attention to how the weather affects your yard. Low lying areas will be colder than higher areas. Biking to work one morning I noticed a yard that lies lower than most of the other yards was frosty, while none of the others were. We have a spot in our yard that floods every spring. I never plant there, but if I did I would wait until after the spring rains had passed.

HARDENING OFF

Before you put your plants in the garden, they should be "hardened off." They need toughened up before they can be released into the real world. Your plants have been growing in close to perfect conditions for their entire lives.

If you set them straight out into your garden there's a chance that the shock of having to deal with the hot sun, cool nights, and wind would kill them. A week before you plan to put them out, give them less water and, if possible, lower the temperature to reflect the conditions outside. If you've been giving the plants any kind of fertilizer like compost tea or vermicompost you'll want to stop until the plants are put in the garden.



This is a good time to separate your seedlings if you're transplanting them directly from flats. Take a knife and cut cubes with one plant in each. This severs roots that would have broken during transplanting. The roots begin to recover before they're put in the garden.

After a week of less-than-ideal conditions, set them outside somewhere that they'll get sunlight, but not sit all day in the blazing hot sun. After a day or two, you're ready to transplant into the garden.

If the weatherman is predicting freezing temps or downpours, bring them back inside. Otherwise, dig a hole for each plant, put the plant in it and cover the roots with soil. The hardest part is getting the plant out of the pot without damaging it—but it's not too difficult.

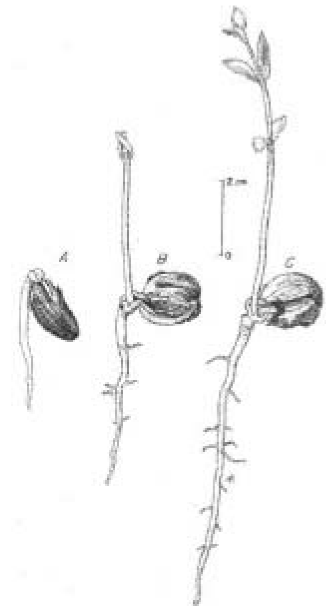


Image provided by USDA

Tip the whole thing upside down with the stem of the plant resting between your middle and ring fingers. Don't squeeze it; if you damage the stem the plant will most likely die. If the plant and dirt doesn't come right out, pressing on the bottom of the pot will usually coax it out.

It's good to throw a handful of compost in the bottom of the hole before putting the plant in. The hole should be deep enough to cover the plant at

least as far as the soil covered it in the seed flat/pot.

Plant tomatoes deeper. If you trim some of the bottom leaves and cover the leaf nodes with soil, those leaf nodes will grow roots. Cabbage, broccoli, and lettuce can be planted a bit deeper too if the stems are long. But don't get dirt on top of the leaf nodes, or it will encourage rot.

Peppers should not be planted deeper—only as deep as they were growing in the seed pot. Like transplanting seedlings from the flats to pots, make sure that the roots are generally pointing down and that you're not folding them back on themselves. Fill the hole with dirt and press it down so you don't have a lot of air around the roots, drying them out.

An overcast, damp day is a good day for transplanting because the sun and wind can dry out new transplants. You can also have good luck on warm, sunny days though. Make sure to do one transplant at a time so the roots don't dry out in the open air. Put a good amount of water on each seedling as soon as it's done. Until the seedlings are well-established, be careful watering so you don't disrupt them. Good luck!

RAIN GUTTERS

Prerequisite to rain barrels…

…possible solution to a leaky basement

Rain gutters are time consuming and expensive, but are a necessary part of rain barrels—and fortunately, fairly easy to install! Also, if you have trouble with water leaking into your basement, putting on gutters with downspouts directing the water well away from the house can solve the problem. Our basement used to flood every time it rained hard. Since putting on the gutters it hasn't flooded once.

Your local hardware store should have a selection of gutters to choose from. Most come with limited instructions.

The tools you'll need are minimal:
- electric screw driver (drill) and extension cord
- ladder
- yard stick
- tape measure
- hammer
- marker

The first thing you need to do is take measurements. While you're walking around the house measuring, take note of how many corners you have and which way they go. Figure out how many downspouts you want. Don't go to the store and guesstimate. It makes for a lot of extra trips to the hardware store.

Gutters usually come in 10' sections, with separate corner and downspout pieces. On the vinyl ones, you will need to screw in a hanger every 24". Where the sections connect, you'll need a connector which looks like wide hanger with rubber seals. The gutter snaps right in.

You can minimize all the climbing up and down by keeping everything you need on hand in a tool belt. Also, hang your drill and a bag of hangers and connectors to your ladder.

Bring up a piece of gutter to use for measuring rather than trying to accurately measure from one connector to another 10' away with a tape measure. Put the gutter in the last connector and mark where the next one needs to go with a marker. I did this by climbing up on the roof, so I wouldn't have to move the ladder. Also, if you need to cut a piece short, bring it up and mark it. Again, much easier than getting accurate measurements with a tape measure. For the 24" measurements from hanger to hanger, it's much easier if you use a yard stick than a measuring tape.

When you install your downspouts, make sure to use a couple of 45 degree

elbows to bring it right up against the house. Then use a couple downspout straps to screw it to the house. Otherwise it will constantly fall off.

If you're not installing a rain barrel underneath, at the bottom you'll need something to direct the water away from the house. The best thing I've found is to connect a piece of vinyl gutter to a 45 degree elbow at the bottom of the downspout. Use a couple short screws on each side. This way it can be swiveled up out of the way for mowing the lawn (or rolling bicycles behind the shed where the cops can't see them.)

Having put up both vinyl and metal gutters, I recommend metal. They're

about twice as expensive, but they will last much longer. I think they're probably more environmentally friendly than vinyl, too. They're also faster and easier to install, though I think you might need two people to do a whole house.

If you go with metal, make sure you go back over all the seams with caulking. If you need to cut the metal gutter or downspout, use an angle grinder with a cutting blade. It's faster than a hacksaw and makes a nicer cut. The connectors can be a bit finicky as well, but using a short 2x4 to tap them together makes that easier.

I was frustrated that it took a whole day to accomplish and cost over $300 to do our house, but right after I got the gutters on, we had one of the wettest years on record. We didn't have any trouble with water in the basement. Now we can do some work on our basement. We've been thinking about installing a little studio, but we didn't want to do anything until we could get the leaking to stop.

And now that the gutters are up, I can install rain barrels!

WATER

The world is on its way to starving for water. Rivers are diverted and sucked dry; some no longer reaching the ocean. Others that fed lakes have dwindled and the lakes are disappearing. Owens Lake used to cover 200 square miles but after the Owens River was diverted to quench the thirst of Los Angeles, the lake disappeared. Mono Lake has dropped 35 feet since Los Angeles started diverting its tributaries. The Dead Sea has dropped almost 80 feet and could disappear by the middle of this century. The Aral Sea, once full of thriving ports and one of the world's largest freshwater bodies has lost 4/5ths of its water after Russia decided to divert two rivers that fed it. Ships sit at docks in the sand with no water in sight. Seas have receded as much as 165 miles from original shorelines! Thousands of lakes have disappeared entirely.

When lake or river water isn't available, wells are drilled. In much the same way that river water is overused, the underground aquifers are over-pumped. Wells are drilled deeper and deeper to reach the water table. Farmers in Saudi Arabia are pumping from 4/5ths of a mile deep!

Aquifers cannot replenish themselves as fast as they're being drained. Others, stored up from wetter times, are non-replenishable and once drained will be dry forever.

Agriculture makes the heaviest demands on water, which is why it is so important for us to adopt sustainable methods of growing our food. It's not surprising to hear that irrigation accounts for 70% of water use. It is surprising that it takes 1,000 tons of water to grow 1 ton of wheat!

Industry use accounts for another 20%. Producing a car uses 12,000 gallons of water. It takes 14 tons of water to make a ton of steel.

The remaining 10% of water goes to residential use. Although we can make a difference in water use by the things that we buy, we can feel like we're making a difference, because it's direct. 20% of residential water is used to transport our urine and feces away from our house. Another 20% goes to bathing. 15% is used for laundry and the remaining 10% goes to dish washing and kitchen uses. 35% goes to lawn, garden and other outside uses. It's a great place to start reducing our water use!

Rain barrels are a great solution. Rain water can be collected and used on your garden. Rainwater can be used for everything else too! 3 million Australians rely on rainwater as their sole source of water. Even if you weren't comfortable ingesting rainwater, drinking and food preparation account for only 5% of water use, leaving 95% of your household use that could be supplemented by rainwater! It's rather incredible to think that all of the water that comes into our house has to be suitable for drinking whether we're actually drinking it or using it to flush away our crap.

Recently I was reading a book about an Australian family trying to live self-sufficiently and found out about how much they rely on rainwater in Australia. I knew some houses used to have cisterns for their water supply, but I never really thought about using rainwater for almost everything.

Rainwater is better for your garden because it doesn't contain additives like chlorine and fluoride. It's also slightly acidic which helps plants access soil nutrients. It absorbs small amounts of nitrogen which the plants can access directly.

Collecting rainwater also diverts water from storm drains, which reduces the amount of pollutants being carried to the river. It reduces the velocity of water entering rivers and streams. In the natural world, water slowly finds its way to the river. But urban/suburban/residential areas are nearly covered in impermeable surfaces like roofs, driveways, sidewalks, roads, etc., which quickly direct all that water directly to rivers and streams, carrying all the pollutants and sediments with them.

RAIN BARRELS

You want to capture rainwater from your roof? The first thing you need is barrels.

There are many places where you can buy used 50 gallon barrels. Stick to food-grade barrels and avoid ones that were used to hold oils or detergents. You can also buy new water barrels at farm stores or, most economically, 35

gallon plastic garbage cans for about $8.

Rain barrels can be as simple or complicated as you want them to be.

For the simple variety, cut a hole in your barrel lid the size of the gutter downspout. Then cut the downspout short and put the barrel under it. Hang a pitcher nearby and scoop out water for your garden when you need it. Whatever you do, keep a lid on your barrel to prevent children and animals from falling in.

To keep the barrel farther from the house—for instance if you are concerned about any overflow flooding your basement—buy some extra lengths of gutter and elbow joints and build the connection. You may have to get a little creative passing it over sidewalks or running it along the tops of fences. I've seen some that were yards long and real works of art!

To make your rain barrel easier to use, you can add a hose attachment. You'll need a brass faucet (otherwise known as a ½" hose bibb) and a metal washer and rubber O-ring that fit over the end that threads into the barrel.

Use a 3/4" hole saw to cut a hole a few inches from the bottom of the barrel. You want it high enough so you can still attach a hose, but low enough so you can get out most of the water. Put the metal washer on the faucet first, then the rubber O-ring, and thread it into the bucket. If the top of your barrel opens, you can add a little extra security and strength by securing it from the inside. I used an internally-threaded PVC coupler as a nut, sandwiching another rubber O-ring and washer.

To keep your collected water relatively clean, build a "roof washer." This is a bucket on top of your barrel that collects the first rain from the roof and makes sure that all the leaves, dirt, and bird crap don't go directly into your rain barrel.

For the roof washer, you'll need a five gallon bucket or something similar. Get a couple of 2" PVC adaptors, one male and one female, and a 90 degree elbow to go with them. Use a 2" hole saw to cut a hole near the top of the bucket.

Stick the male adaptor on the inside and screw in the female adaptor on the outside. Attach the elbow and place it so it directs water into the hole in the top of your rain barrel. Place a piece of screen over the hole or a nylon stocking over the pipe to keep debris out.

Place the end of the downspout into the bucket. When the bucket fills up with the initial, dirty run-off, the cleaner water will start running into the barrel.

Once you have a full barrel of water, use it to water your lawn. To speed up water flow, put them up on concrete blocks, or even better on a deck or second story porch. The extra 8-10’ gives you as much pressure as using the spigot!

You might want to consider an overflow system for your rain barrels that will direct water away. You can put a PVC fitting near the very top of the barrel so when water gets to that level, it starts flowing out through the fitting. A hose can further direct overflow away from the house. This could be connected to a second barrel, that starts filling when the first one is full.

My friend Nikolas likes a different method: drilling a hole big enough for the threaded end of a hose connector, he put an electrical nut on the inside and outside to hold it, and clamped on the hose where it normally goes. He did the same thing on another barrel, and connected them with the hose. To prevent leaks, he caulked it. His system allows the water to flow freely from one to the other, so he only needs to have a faucet on one barrel. I like the overflow system because it has fewer holes near the bottom of the barrel, and therefore fewer chances for leaks to develop. However, his system seems to be working fine.

If you’d like to figure out how many barrels you could fill, here’s a simple formula:

Rain caught (gallons) = inches of rain x 0.6 square foot of roof.

So far example, my garage roof is about 10x10' which means 100 square feet. So if we receive 1" of rain, the formula looks like this

Rain caught = 1 x 0.6 x 100

One inch of rain on my garage roof would yield about 60 gallons of water. That would fill one barrel. My house is about 1000 square feet, so that same 1” would yield 600 gallons if all the water was diverted to rain barrels. That could almost fill 11 55 gallon barrels. The average precipitation in Minneapolis for May through August is 3.5”, so I could collect as much as 2,300 gallons per month.

WINTER

For folks in freezing climates, the rain barrel should be emptied before it freezes. Water expands when frozen and can crack your barrel or pop out fittings. You won’t be able to use the frozen water anyway, so drain the barrel and divert the downspout until the weather warms up again.

BUNG REMOVER

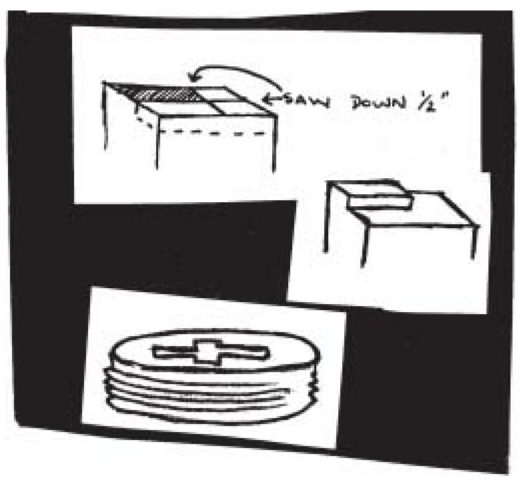
You may have the common problem of being unable to get the plugs out of the bungs in your barrel.

There is a tool you can buy for this, or you can make your own out of a scrap of wood.

The hole in the bung is shaped like a + sign, with a horizontal and vertical slot. Your goal is to make a tool that will fit one of these slots.

Mark the end of a 2x4 with the length and width of the slot. Cut down about ½” on each side. Then cut in from the side of the 2x4 (about ½” down) until you hit the spot where it’s sawn down. 4 quick cuts make a bung tool.

You can grab a large wrench or pliers if you need it, but it should be easy enough to turn the plug out using the 2x4 as a handle.



GREENHOUSE

April 18 2008

I started work on my greenhouse today. As in, I started assembling it. I’ve looked at some books, but everything was either too involved or it was made out of PVC. I don’t want to build a glass glazed greenhouse attached to my house. Don’t get me wrong, that sounds great! I don’t have the cash to lay out for that kind of project. Our only option would be to rebuild the porch as a

greenhouse—and don't think the thought hasn't crossed my mind! So I wanted to build a cheap one that I could put over my existing raised bed garden.

PROBLEMS WITH PVC

PVC is super easy to work with. You cut a few pieces and glue them together. It doesn't get much easier than that! However the ease of using PVC has to be compared to the health and environmental effects of PVC production and disposal.

The first step in creating PVC is producing chlorine. An electric current is run through a salty brine with a catalyst. This produces caustic soda (sodium hydroxide) and chlorine. Nine of the factories that do this in the United States use mercury as a catalyst. These factories only produce 10% of the country's chlorine, but put tons of mercury into the air. In fact, the amount they put into the air isn't definitively known due to underreporting of air emissions data. It's possible that they put more mercury into the air than coal-burning power plants which had been presumed to be the largest producers of atmospheric mercury pollution. This is converted into an organic form by bacteria then absorbed into the food chain.

Very low levels of mercury can cause neurological damage. In 2004 1 in every 6 babies was born at risk for neurological damage from mercury exposure *in utero*. The effects of prenatal mercury exposure include memory problems, short attention span, impaired motor control, and learning disabilities.

Studies show that these problems continue right on into adolescence and researchers have concluded that the neurotoxic effects from intrauterine methylmercury exposures are irreversible. Mercury has also been linked to heart attacks. Fish were once a food that was good for your heart; now the amount of mercury found in fish has reduced the heart healthy effects of eating fish.

PVC workers have increased mortality rates from all causes of death. Tumors, lung cancer, lymphomas, leukemia, liver cirrhosis, liver cancer, brain cancer, etc. Vinyl chloride, part of the production process of PVC, has been shown to be a more powerful liver carcinogen than hepatitis B, which is a well-known cause of liver cancer. The polymerization of vinyl chloride produces powder and dust, which has been linked to lung cancer and other pulmonary diseases in workers. Communities surrounding these factories are constantly exposed to the same chemicals as the workers, through the air and water.

If you know the smell of a new shower curtain, you know what PVC smells like. A 2002 study concluded that a single shower curtain can raise indoor air toxin concentrations for more than a month! Old or damp PVC flooring or carpeting can release volatile organic compounds into the air. This degradation of PVC can cause asthmatic symptoms in both children and adults. PVC is used in toys, infant products (such as bibs), packaging, fashion accessories, garden hoses, Christmas trees, lunchboxes, mini-blinds, and other products.

Bis(2-ethylhexyl) phthalate (DEHP) is the main plasticizer for PVC and is considered to be the worst of all phthalates. A Center for Disease Control study published in 2000 detected phthalates in the urine of almost every individual in the study. DEHP is an animal carcinogen and an endocrine disruptor. The health effects blamed on endocrine disruptors include reduced fertility, reproductive tract abnormalities, reduced sperm count, loss of fetus, menstrual problems, changes in male/female ratios, changes in hormone levels, early puberty, brain and behavior problems like ADHD and autism, impaired immune functions, and cancer.

These problems are especially pronounced in fetuses that have been exposed to endocrine disruptors, because the endocrine system guides the development of the baby and “programs” organs and tissues like the liver, blood, and kidneys so they will perform their correct functions. In utero

exposure can cause permanent alterations and adult diseases. The proliferation of these chemicals threatens our very survival as a species because it has such adverse effects on reproduction and development.

There is no safe way to dispose of PVC. When burned it releases hydrochloric acid mist and dioxins. Dioxins are a carcinogen and another endocrine disruptor, and among the most toxic contaminants known to humans. Also, the lead and cadmium used as stabilizers is freed from the plastic and turned into ash, from which those heavy metals can more easily be leached. These heavy metals also make recycling difficult because they're dispersed during the recycling process. Even when it is recycled, the quality of the recycled material isn't as good as the original. If inadvertently mixed with bottles, PVC can ruin an entire batch of 100,000 bottles. Even when not burned, the heavy metals still leach out. One study estimates that 28% of the lead in landfills comes from PVC products.

Building a greenhouse out of PVC seems like a terrible idea! So I didn't.

THE PLAN

Greenhouse plans require you to buy large sheets of greenhouse plastic. Most of the plans cited this as the biggest expense. I have rolls of plastic in my basement that I've picked up on clearance or rebate for nothing or next to nothing. They normally run about $4-5 a roll. The plastic isn't quite as thick as greenhouse plastic but I think it will work fine as long as I fm careful not to puncture it.

I came up with a design that would allow me to use these standard rolls of cheap plastic: build the greenhouse in panels. The widest panel is 8' wide, and the narrowest is 4' and could easily be covered individually by the 10 f wide plastic.

The greenhouse is built from 6 panels: a panel on each end, a panel for each side of the roof, and a panel for each side. The benefit of this is that the panels

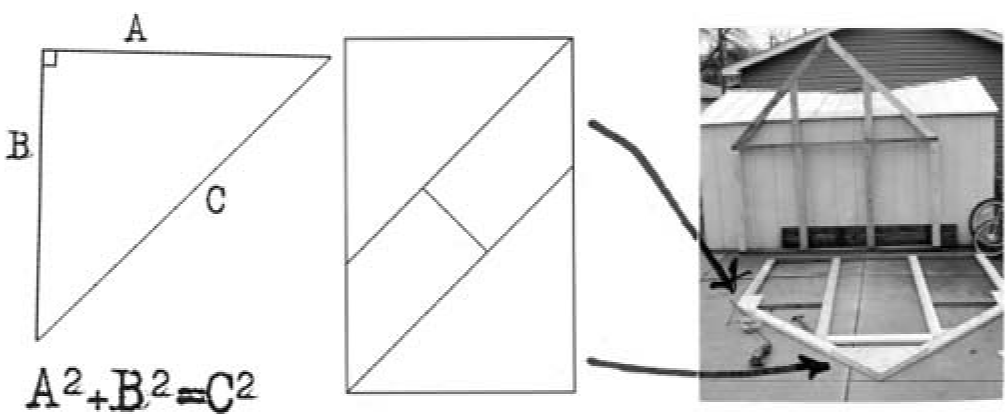
can be taken apart. This makes it easier to put on new plastic if the old wears out. Also, if the greenhouse has to be moved or stored for some reason, the whole thing comes apart and can be moved or stored as flat panels.

I made the design easy to build for about anyone. With the panels set up the way they are there is very little mitering that needs to be done.

Keep an eye out for construction dumpsters to get lumber from. I got about 1/3 of the lumber from dumpsters and bought the rest. The rest ran $83.

First, make the mitered cuts. Once the miter cuts are done, all pieces are at right angles and easy to cut and screw. I chose to use a right equilateral triangle for the top, where two equal sides come together at a 90 degree angle, because that meant the only angles I'd have to cut would be 45 degree angles.

Figuring out the length of the rafters is a bit tricky. I looked up the Pythagorean Theorem which is used to figure the length of the sides of a right triangle:



$A^2+B^2=C^2$.

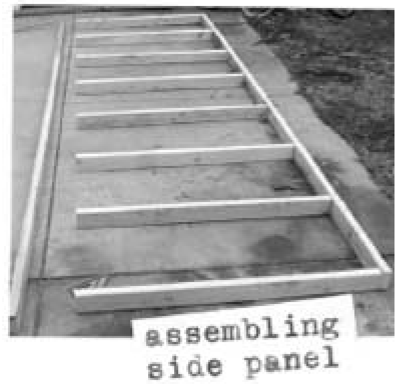
The bottom of the triangle (C) was 96" and the other two sides (A and B) are the same. This simplifies the formula to A = 9,216". Since I knew each of the sides would be the same, I divided 9,216 in half. Now all I had to do was figure the square root of 4,608. Mine worked out to 67 7/8" (67.875"). On

mine, the matching sides of the triangle needed to be 5’ 6 7/8” (66.875”) and 8’ wide at the bottom. Yours will be different if start with something other than 96”, so I included the math here.

Math comes pretty easy for me, but if you’re not comfortable with it, you can get incredibly close with a scale drawing. When I wanted a rough estimate to figure out how much lumber I would need, I drew up my design on graph paper using 1 square for every 6”. Then I cut a “ruler” from the page and used it to measure the length of that side of the triangle. I came up with 5.65’ or 67.8” which is pretty darn close to the 67.875” I got using a complicated mathematical theorem.

We’ll first do the side without the door because it’s easier. It’s a rectangle on the bottom with the two equal sides of a right triangle sitting on top. Cut the pieces and lay them out to make sure they fit. If so, screw them together. Then, to give it strength, put a couple ribs in the rectangle. It wasn’t as stiff as I wanted, so I grabbed the scraps left over from cutting the rafters, cut the long one the same length as the short one, and nailed them into the triangle.

The other end needs a door. Figure out how wide you want your door and take measurements from the completed end to figure out the lengths of wood to create your door frame and the braces that come from the corners of the triangle to the door frame. A piece of plywood cut like the diagram below will provide two plates for the top and two for the sides. If I was going to do this again, I think I’d put a door on each end because the 2x4s going from top to bottom really stiffen it up. I ended up adding additional braces on the window side to give it a bit more strength.



You have to put together two sides that are 14’ long and 4’ 3” high and two roof panels that are 14’ long and about 6’ wide. Since there are no mitered angles or anything complicated like door openings, things should go very quickly. Then it’s only a matter of stapling the plastic on and screwing the panels together. (See “In Hindsight” to read about the changes I would have made to the panels.)

Next, start on the side panels. Mark your 14’ 2x4s every 2 feet. Lay them out with 4’ studs between them centered on each mark. Use a couple nails on each end to hold the studs in place. For extra security I added screws on the end, but I didn’t have enough to do the whole thing with screws. Another thing that helps is putting diagonal braces in a couple of the corners. I took a couple scrap pieces of 2x4 about 2’ long and cut 45 degree angles on both ends so they could fit into a corner. Then I nailed them in place after making sure the corner was square. These do a good job of keeping the panels square.

Now do the 14” by 6” 3” panels the same way. Lay out your 14’ 2x4s with 6’ 2x4s between them and nail them together.

Up until this point I was using salvaged nails (see section “Salvaged Building Materials”) but my kids wanted to help. Driving nails is tricky enough when you’re 7 or 8 years old without trying to drive bent nails that have been straightened. So I hopped on my bike and went to the hardware store for a box of 3.5” 16-penny spiral nails. I would drive in the first nail on each stud, and then they’d come behind me with a straight new nail and knock in the second one. Things took a little longer, but they like helping and it was a good learning experience for them (see section “Homeschooling”).

For the 6’ wide panel, I used 8’ wide plastic. First off, don’t try this if it’s breezy. It makes it nearly impossible. Wait for a calm day. I laid the plastic on the ground and then the kids helped me set the panel down on top of the plastic. Then I wrapped the plastic around and stapled it on. I started on one corner of one end working across the short edge, pulling it tight as I went. Then with some help from the kids I pulled the plastic tight across the whole length of the panel and stapled it across the other short end. Then I folded over the plastic on one corner and stapled it before going down the entire 14’ length, wrapping the plastic around the 2x4 and stapling it.

The last edge I made sure I pulled the plastic very tight before stapling it. I'd pull it tight, put in a couple staples, move down a few inches pull it tight and repeat.

Part of why I designed the greenhouse the way I did was because I could put plastic on both sides of the panels. Since the plastic I had for the side panels was 10' wide, I wrapped it all the way around covering both sides. This would leave an air cushion of 3.5" which would help to insulate the plants against the cold. There's a window on one side and a door on the other, so if it gets too hot I can open up both and get some air moving through there.

Wrapping the ends with plastic is a bit tricky because of their angles. Also, you can't easily wrap plastic around odd objects (like a door opening) and staple the plastic on the other side. I did each side of the door separately, wrapping the plastic around the outside edge and through the hole for the door. This meant cutting the plastic to get it around some of the 2x4s, but it seemed to work out okay.

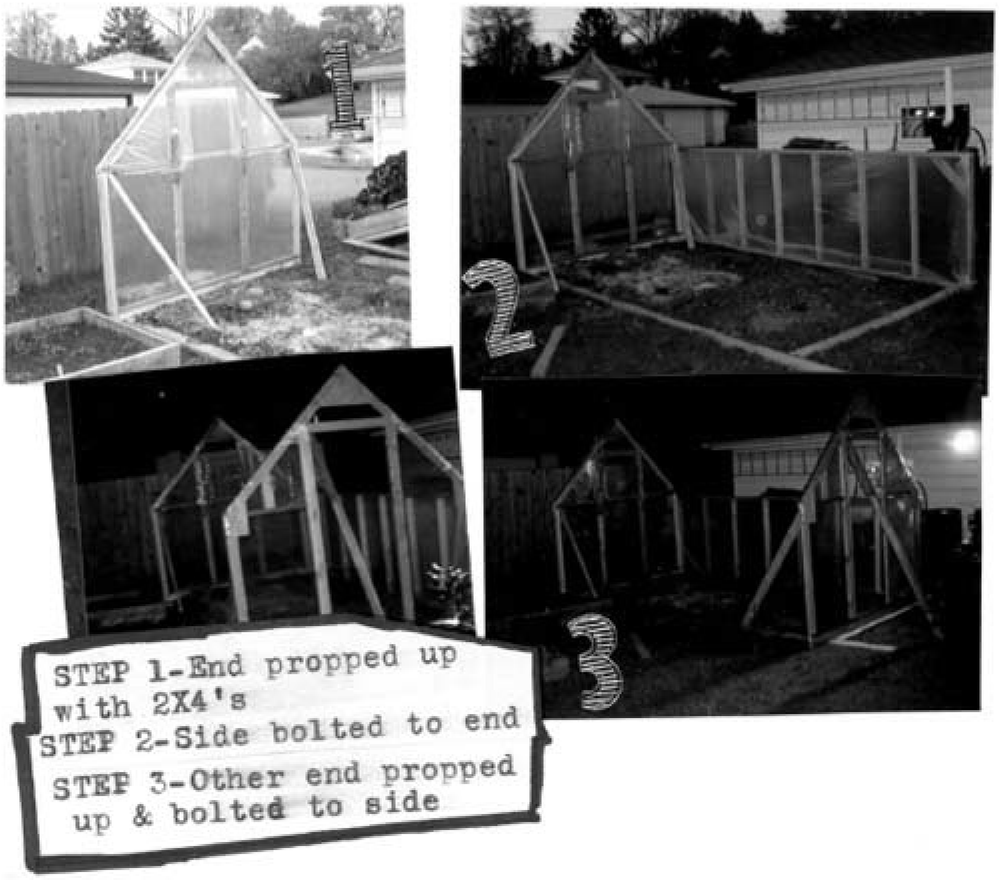
This left a 6” gap under the plywood brace at the top. I think that rather than covering that with plastic, I fm going to use a piece of wood. I’ve considered putting some little hinges on it so that it can be opened and used as a vent.

On these panels I decided to use pieces of lathe to hold the plastic on. I think the extra area holding the plastic down will help prevent it from ripping. So when I wrapped the plastic around the edge and pulled it tight, I would put down a piece of lathe and kneel on it to keep the plastic taut. Then using 9/16” staples I stapled through the lathe and into the panels sandwiching the plastic in between. Make sure you’re not putting the lathe where it’s going to get sandwiched between two panels.

Before putting the plastic on this last panel, I framed in a spot for a window. I also made a very small frame in one corner of the triangle so I could cut the plastic later and run a tube though it. This way I can put a rain barrel in the greenhouse and have the water run directly in there. This will serve two purposes. The water in the black barrel will retain the heat from the sun, giving it off at night after it starts to get cool. Also, since the rain won’t make it to my gardens anymore, I want to have water close at hand to do the watering without using city water. One thing I’ve considered is to make an overflow tube that runs to homemade soaker hoses in the garden. That way, the rain barrel gets filled up andthe plants get watered “naturally” when it rains.

ASSEMBLING THE PANELS

One thing I didn’t take into consideration when designing this greenhouse was the weight of the panels or the awkwardness of carrying them once the plastic was on. Having an extra person or two to help you during the assembly process would really make things go a lot easier.



I assembled the whole greenhouse using 5" long ¼" hex head galvanized lag bolts. I pre-drilled the side panels first so that a lag bolt could slip right through. To prevent ripping the plastic, you can staple a 1x1" piece of lathe where you're going to drill the hole, and drill through that. Make a hole about a foot from the top and the bottom. (See "In Hindsight" for changes I would have made in assembling the greenhouse.)

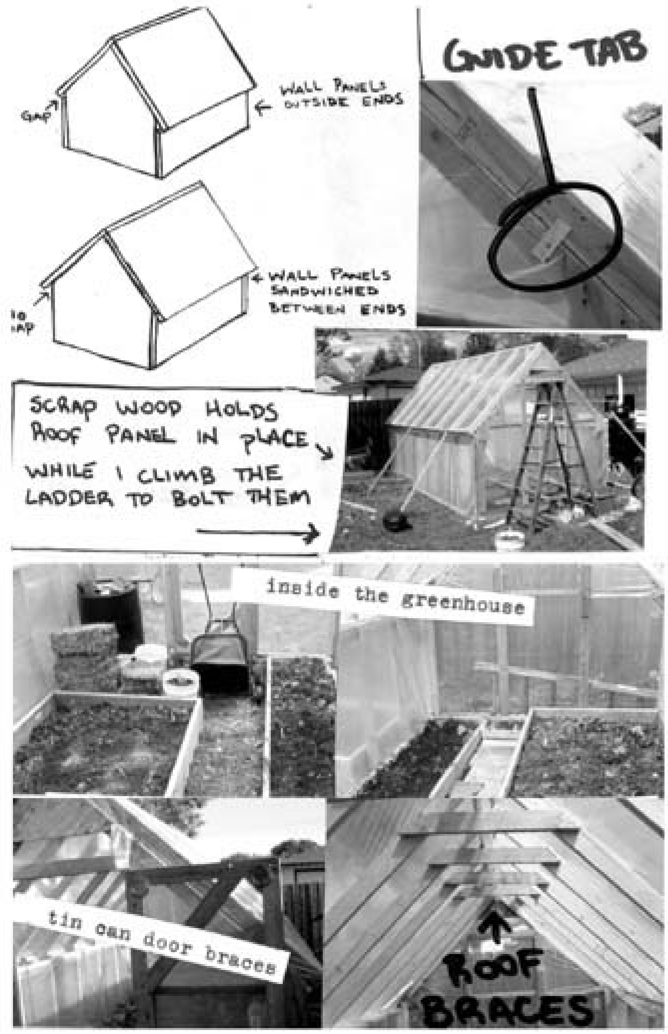
If you're doing it by yourself, start by propping up one end with some 2x4s. Line up one side and drive lag bolts through the pre-drilled holes. Once you have the first side attached, do the other end the same way. Again, prop it up with 2x4s while you drill the holes and drive in the lag bolts. Once you get the last side attached, it will hold itself up.

A socket attachment on your drill is a real timesaver. I used it for putting all the lag bolts on the greenhouse and it's a lot quicker than doing it by hand.

You do need a good drill, though. I always use one that you have to plug in because they seem to have more power. Cordless ones always run out of power at the most inopportune time.

Now, pre-drill holes for the roof panels in the same way as the side panels. Cut some pieces of lathe about 3” long. You’ll use these as guides for placing the roof panels. Screw them on the outside of the end panels so they’re sticking up about 1.5”. These will be imperative if you’re putting the roof panels on yourself. They keep it from sliding off to the side while you’re pushing the panel up the incline. Without them, the panel will fall off to one side and you’ll rip your plastic.

I brought the roof panel over and set it right next to the side panel so that the ends lined up with the ends of the greenhouse. I grabbed it by the bottom and started pushing it up the inclines. If you’ve ever been in a science class, you probably know that an inclined plane is one of the six simple machines. It’s not an easy job but it can be done. Be careful not to catch the plastic on anything and rip it while sliding it up there. Stick a couple 2x4s under the edge of the panel so it won’t slide back down. I had my daughter do this. Make sure it’s lined up exactly where you want it, and then bolt it in place. Do the other roof panel the same way. One panel will slightly overlap the other at the peak.

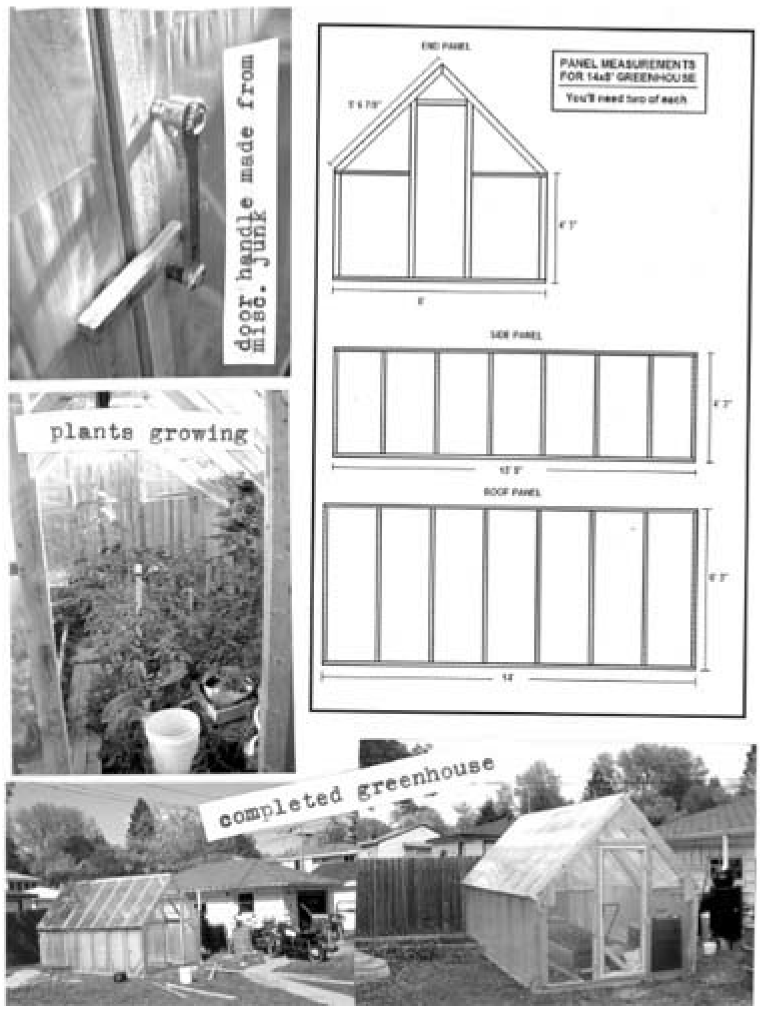


Once I got the whole greenhouse together, I screwed some metal plates where the panels came together. It's probably not necessary, but it makes me feel better.

Another thing I did was put braces between the roof panels. Since I couldn't get to the top of the greenhouse to screw the roof panels together on top, I decided to use braces underneath which I thought would probably be better anyway. I used some 2x4 scraps cut into 2' lengths with a 45 degree angle on each end. Then I screwed them to the rafters in the roof panels.

Lastly I made the door. It's a rectangle that fits the door opening with a

couple diagonal braces inside. I also used tin can lids in the corners as reinforcing metal plates. I used pieces of lathe to staple plastic to the outside of the door. I also stapled a piece of lathe inside the door frame where the door rubs against the frame when opening and closing to prevent the plastic from ripping. I had three interior door hinges in one of my boxes of miscellaneous household junk. I used two of them to hang the door on the greenhouse. Then I added a handle made out of junk and a latch to hold the door closed. You can make a window in the same way.



IN HINDSIGHT

Rather than having the wall attach to the outside edge of the end panels, they should be sandwiched between them. The roof panels will still sit on top of the end panels, but now the roof section will rest on the walls as well. In order

to do this, the side panels will have to be three inches shorter than the roof panels. On my greenhouse, the roof panels would have been 14’ long and the side panels would have been 13’ 9” long.

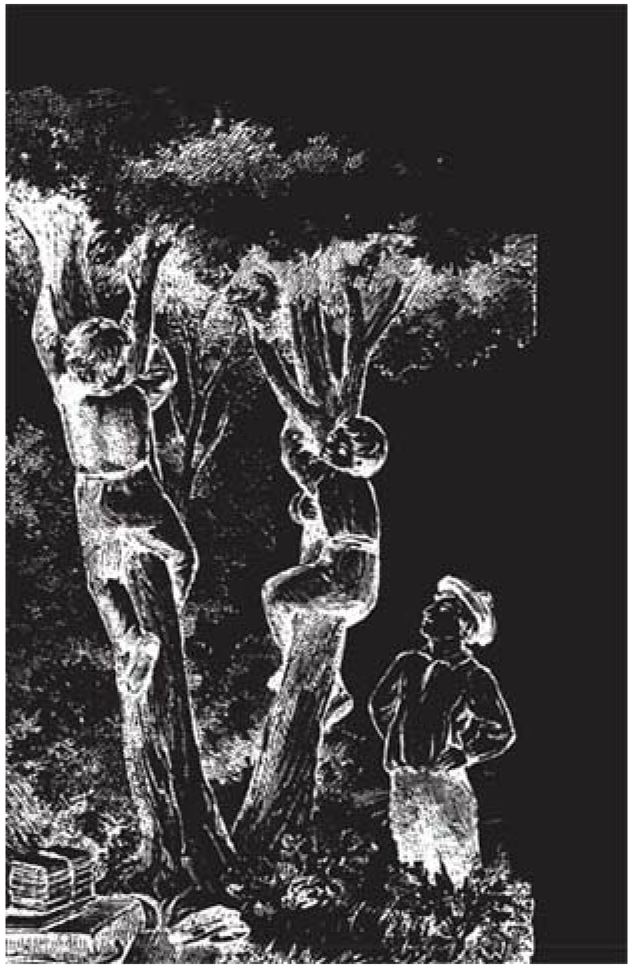
Due to the weight of the sides and the risk of tearing the plastic, you could build the whole thing like a shed and then wrap it in plastic afterwards.

After stapling the plastic as described, you should go back and use pieces of lathe to staple it to the front of the panels as well. Not necessary around the edges, but helpful along the studs and rafters that pass through the middle of the panels. This will prevent the wind from whipping the plastic around and ripping it.

The ultra cheap plastic didn’t hold up to the elements too well. I was using 3 millimeter plastic and that only lasted about a year. I think I would try the slightly more expensive 6 millimeter plastic and see if that doesn’t hold up better.

Lastly, make sure you check city regulations before building a greenhouse. I checked but not quite carefully enough. The reason I chose the 14x8’ dimensions was because it was less than 120 square feet. Larger than that, I would have needed a permit. Unfortunately, I didn’t realize that because I already had a shed and a garage I couldn’t have another external structure. A neighbor complained and I had to get rid of it. Something positive did come from it though. I was able to disassemble it and load it onto a trailer with the help of another person. It only took about 30 minutes. This proved my theory about the ease of moving a 6-panel greenhouse.

EDUCATING YOUR CHILDREN



CHILDREN AREN'T THE FUTURE… THEY'RE THE PRESENT

EDUCATING YOUR CHILDREN

My wife and I had already practically decided how we would educate our children before we even met. Both of us hated school beyond your standard "I hate school! I want to stay home and play!" Not that there is anything wrong with that either.

We both had a true desire to learn and school wasn't educating us—it was holding us back. There were so many things we wanted to do but school had bound up our time.

Public school is one of the worst learning environments imaginable. It discourages individual thinking. It discourages self-motivation through time and subject constraints. Everything is divided into unnatural categories, which creates a skewed sense of how real life works. One teacher is assigned to every two or three dozen students who all learn with different styles and at different paces, so everything takes longer than it should.

We both wanted to know why we were learning what we were learning. We wanted to know why things work the way they do. It wasn't that we couldn't regurgitate the information. The problem was we didn't want to. We wanted

to learn. “Why?” is the one question teachers will rarely answer. That’s because the school system isn’t actually about educating children or teaching them to learn.

Rachael and I have always seen public school as a way to condition children. It prepares you for jobs where a large portion of your day is planned. You are told when to come in, when you can take a break, when you can take lunch, and when you go home. And, of course, during that time they tell you what you are supposed to do. School’s main purpose is to train the future working class to accept their lot in life. First they break your will, water down your passions and steal your dreams. Then it’s easy to convince you that the American dream is your dream.

In 1818 when a primary public school system was forced on Boston, one of the main reasons given was that children living in poverty needed to be rescued from neglect and have their characters formed—or they would become the criminals of tomorrow! That same mentality lives on today. Those who don’t attend school can only be expected to turn into criminals or become homeless because any environment outside of school is sure to corrupt the child. Any parent who chooses to keep their child at home does so because they have nefarious secrets to hide. This was the exact thinking that spurred on anti-homeschooling legislation only a short couple decades ago.

I don’t know about you, but I don’t want my kids trained to be content doing some menial job for a paycheck. I don’t want them to do exactly what they’re told without ever thinking about it. I want them to understand that there are other options, and I want them to be confident and passionate enough to pursue their own interests.

I don’t want them trained to be patriots who take the government at its word. I don’t want them brainwashed into believing that the current financial and governmental systems in the U.S. are the apex of society. I don’t want them to be immersed in a climate of hedonism and nihilism, or trained to self-

medicate with drugs and alcohol.

Instead, I try to teach my kids a strong moral foundation. Much of it is about how to treat other people. We believe that we're called to love—not only our friends or the people who can do something for us, but everybody, even our enemies. That means we take care of the needy and do it without expecting anything in return. It means that we show mercy, and refrain from judging others. It means that we don't use people for our own advancement but instead treat them the way we want to be treated. This is in total opposition to the "success at all costs" mindset taught in school.

SOCIALIZATION

Whenever we tell people that we homeschool, they always want to know how our children are socialized. We get questions like, "So, do you belong to a homeschooling group or something like that?"

In public school, you throw together a bunch of kids who don't really know how to socialize. The teacher attempts to teach them how, but not in the way that the real world operates. When children want to speak, they have to raise their hand. Talking person-to-person is generally prohibited and all conversation must be mediated by the instructor. When kids don't follow instructions, further instructions are barked at them. If they want to use the bathroom, they have to ask permission.

On top of all that, they're segregated by age. That's completely unnatural. They are isolated from older children who may have actually learned some social skills (or other skills) that could be passed along. All learning must come not from their peers but directly from the teacher. What kind of socialization does that teach them? All this teaches kids is a skewed herd mentality. It teaches that all learning must come from a trained authority.

Outside of that, they generally learn only bad habits, and because there's only 1 adult for every 30 kids, there's no way to temper all those habits as they

develop. There is constant striving to claw your way one step higher up the social ladder. Even if you're a total outcast, you have to find someone worse off than you and ridicule them. At my school there was one kid who was an even bigger loser than me, and because of that he had to endure me putting gum in his hair one day on the bus. Those aren't the kind of lessons that I want my children to learn. I want my children to be confident in who they are and be kind to those around them no matter what their status.

But to answer the question: yes, our children are in a homeschooling co-operative.

Mostly it's a time for them to get together and have fun with other kids. Some years they write skits and work on other larger projects, but mostly it's a "physical education" time where they get together and play games. The main difference between the co-op and public school phys-ed is that they don't have someone constantly barking orders at them or other kids belittling them. Also, kids of all ages play together happily.

Nobody is perfectly socialized and our children are no exception. Our daughter is sort of shy and can have a hard time making new friends, but I'm sort of shy too, and I think that probably comes from public school. I really like interacting with people, but I'm constantly trying to push through insecurities ingrained by 13 years of being an outsider. Public school isn't the way to ensure socially well-adjusted kids.

It doesn’t make sense to worry about kids who spend time with their family instead of herds of children. I mean, what could be more natural? Shouldn’t that be our goal instead of handing our children over to someone else to do the parenting for us?

LEARNING STYLES

Before you start homeschooling, pay attention to your child’s learning style. Doing this may have made things easier with our daughter during that difficult first year. She isn’t a visual learner, so setting her down in front of a lesson book and telling her to do it didn’t really work for her. We later figured out that she was a hands-on learner, especially when there’s social interaction. It was partly about the hands-on part but more about the conversation.

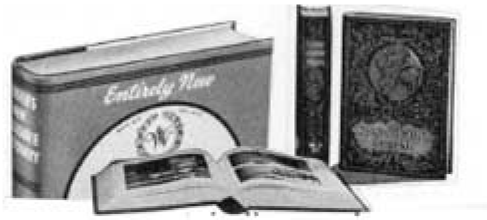
Our son also enjoys hands-on learning, but he can sit down with a book and do his lessons without needing someone to talk through it with him. That’s the way I was in school. I didn’t want someone to waste my time with lectures: cut to the chase and give me my assignment, so I can finish it and move on to some writing or drawing or reading or something!

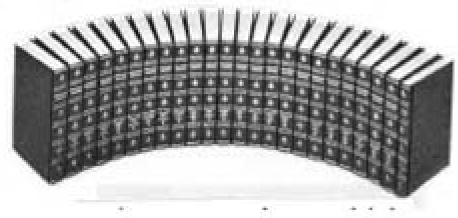
So pay attention to how your child learns, and figure out how to make their education work for them. Do a lot of reading about different methods and styles and use the parts that work. A method may sound like a dream come true for you, but if it doesn’t fit your child’s learning style it could end up

being hell for them.

HOMESOHOOLING LAWS

Make sure to research the homeschooling laws for your state.





I would highly suggest that you contact your local Department of Education rather than a local school. Public schools receive funding based on enrollment. The more children they have the more money they get, so it is in their best interest to make the homeschooling process seem difficult or impossible. It is not unheard of for schools to attempt to make you fulfill additional burdensome responsibilities, but you are only required to follow actual state laws.

In Minnesota we have to register our kids with the local school district, which includes telling them what our year's calendar will look like. They ask that we submit a summary of our curriculum with that registration, but we have always put down "curriculum available upon request." That first year, we did a pretty good job of keeping track of exactly what our curriculum was and what Esther was learning. We stopped keeping detailed records after a couple years, figuring that we could easily put together a summary if it was requested.

We also have to submit report cards during the school year showing the kids' progress in standard public school subjects. When it comes time to do the report cards, Rachael thinks back on the previous quarter and puts down how she feels the kids have been doing in each subject. We don't put a lot of weight on them—it's something we have to do to comply with the state's requirements.

Lastly, the kids have to take a basic skills test every year to make sure that they are keeping up with other kids their age. Rachael and I thought this was pretty funny after we got something in the mail one year to show what wonderful schools our city has. We took a look at the test scores and noticed that, in some cases, less than one-third of students were even passing the test. Overall, the test results showed that over 44% of kids passed either reading, writing, or math. They were making us take a test to make sure that our kids were up to snuff, but 66% of their children were failing!

Discouraging as some of the laws are, they could be much worse! Many people have fought long, hard battles to keep homeschooling legal.

An effort to outlaw homeschooling in Iowa included ramping up truancy laws and then trying to make it so that homeschoolers would be considered truants. Parents could have had their children legally taken away and put in protective custody because they were schooling their children at home. Families fled the state to avoid prosecution and an underground railroad was set up so that families who were being investigated could get their children to safe houses.

Twenty years ago, homeschooling was illegal in Texas. Their attorney general at the time didn't believe parents were qualified to raise their children, much less teach them at home. Almost 100 families were prosecuted for homeschooling. Thanks to aggressive activism by homeschooling families, the practice is now legal.

Homeschooling is now legal in every state and many don't even require notification that you'll be homeschooling your children. Many states do have laws and you'll need to find out which apply to you. The website for the Home School Legal Defense Association is a great resource. They have laws listed for every state and a lot of other helpful information as well.

GETTING STARTED

When we first started homeschooling Esther, we didn't really know what we were doing. We found some curricula that Rachael had done when she was a kid and that she liked. Since Rachael was the one staying home with the kids, she set up the school day, which started right after breakfast. She'd sit down with Esther and help her get started on one of her lessons and then Esther would take over from there.

But Esther, unlike Rachael and I, wasn't very self-motivated. When sitting in front of her book, she would find a hundred other things to occupy her mind. Even now when she's supposed to be doing school, I'll see her sitting there bouncing her pencil up and down on the table, completely involved in watching that pencil bounce.

In the beginning if Esther was having a tough day, we'd push through it. We pushed so hard that after the first year we were worried that we'd ruined her for reading, because she did not want to read for a long time. Now she enjoys reading again, which is a relief!

These days we don't fight her so much if she lets her mind wander off. We've all learned that it's not so much about putting in time as completing the project. When we first started, though, we would try to make her do her work. We'd get frustrated because she wasn't doing her work and she'd get frustrated because we were forcing her to do it. We didn't intend to be so hard-nosed about learning, but we were anxious knowing that she would have to be tested at the end of the year, and that our permission to continue schooling her relied upon the results of that test.

That's why I recommend not enrolling or registering your children until you absolutely have to. If we had taken that first year to try things out and see what worked best without having to worry about test results, I think things would have gone a lot smoother. We didn't register Jedidiah until we were required to at age seven. At that point we'd already done kindergarten and first grade with him, but we registered him as a first grader which gave us a

little breathing room. At the end of the year we tested him as a second grader. He did fine and the next year we registered him as a third grader.

If the kids are having a hard day now, we'll scale back and revisit the subject later in the week. We've learned that trying to push through those hard days doesn't work. You end up with both the kids and the parents aggravated and nobody learns anything anyway. However, if your child is having hard days almost every day, it's probably time to re-evaluate their learning style and see if you can't find a way to make the learning more enjoyable.

RELAXED APPROACH

That first year we pretty much did public school at home. Although we didn't have full-length days, we had school five days a week, structuring the day around the curriculum. These days we take a much more relaxed approach. Now the kids do school four days a week, Monday through Thursday. They usually spend less than four hours each day doing school, which means that they're often done by lunch time. On Friday they can work on their own projects. Occasionally they use Friday to catch up if they've fallen behind during the rest of the week.

As relaxed as we want to be, the kids still need to learn what the state says they should be learning. Every year they take the Iowa Basic Skills Test which is the annual, standard test that determines the progress of all U.S. school children. Every year our kids have scored well above the 90th percentile overall. One year Esther was in the 99th percentile, which is as high as you can get.

We don't give a lot of credence to the test results, because they were created to measure the progress of children in the public school system. Especially as the children get older, the tests determine not whether they're mastering "practical skills" but whether they're accurately regurgitating the indoctrination they receive in school. Don't believe it? Wait until you see your kid's yearly tests and the kind of subjective questions they include. We

combat this by teaching them what THEY expect them to answer, and what we really believe. We usually do this at the end of the year before they take the test. This state compliance garbage is Rachael's least favorite part of teaching. The tests can be somewhat useful though, because they're broken down into different subjects. This makes it easy to determine that our children are academically keeping up with other children their age, or (occasionally) that they need a bit more help with something. This last test had Esther in the upper 80th percentile for spelling, so we figured it might be time to focus a little more on spelling. Overall, the tests show that our relaxed approach is working.

CURRICULUM

We currently do set math and English curricula with standard homeschooling books that help us keep up with the tests. We do our best to try to incorporate both into actual life circumstances so the kids will retain them better. For everything else we use a combination of unit studies, unschooling, and Charlotte Mason's methods that Rachael likes to call "fun-schooling" but which is more accurately called eclectic homeschooling.

UNIT STUDIES

Once the kids became old enough, we began starting out the year by asking them what they want to learn about. Rachael always says, "Your efforts are in vain if the kids aren't interested." Sometimes they say something like "Legos" which doesn't work so well. Sometimes they come up with something that can be used as the basis for a unit study.

A unit study is like learning about something as an adult. You take something that interests you and explore all aspects of it. I studied geometry in school but didn't retain any of it. But when I built my greenhouse, I went back and re-learned it, and it's stuck with me.

Last year the kids did a unit study based on *Little House on the Prairie.* They read the *Little House on the Prairie* books and used that as a jumping off point

to study a bunch of other things, including the plains, Minnesota and Wisconsin, the Mississippi river, U.S. history, pioneer life, hunting, tracking, and food preservation. They also learned about the animals that they encountered in their reading. Wolves, mountain lions, and dogs were all discussed, as were sheep, which lead to studies about wool and dying cloth. They spent a lot of time learning about Native Americans because both Rachael and I have Native American heritage and it's something we want our children to value.

Our kids were really big on ancient Egypt for a while and they wanted to learn all about mummies and pyramids and pharaohs. During those studies they also learned about the Nile River and how agriculture works along the Nile. They also learned about how the cities of Egypt were laid out and drew their own maps.

Of course reading all these books means they are studying literature, and adding in some journaling means they are learning writing skills. They also do a lot of drawing, and sometimes incorporate crafts. They also play a lot of games. Some of them are educational and teach things like geography, sentence building, spelling, strategy, and problem solving. Others are for fun.

NATURAL UNSCHOOLING

Unschooling is a style of homeschooling that recognizes that children are

born with curiosity and an overwhelming desire to learn. Its basic tenet is that there is no need to force a child to learn—they will naturally do it on their own.

When it boils down to it, we actually do quite a bit of unschooling but we're not always intentional about it. We don't necessarily try to take one of the kid's interests and direct it so that they can learn even more from it. We allow the learning to happen.

When we asked the kids what they learned outside of school this year, it took a bit of thinking because those things weren't approached like "school" learning: they were following up on what they were interested in doing. After we got the ball rolling, they were able to think of lots of things. This year, Esther built a musical instrument called a diddley bow. She and Jed both helped me build the greenhouse and learned some bicycle and skateboard maintenance. They got a new dog and learned how to take care of it, as well as a lot about animals in general. They both learned about gardening by helping me in the garden and about baking by helping me in the kitchen. Esther learned some cooking and now loves to cook whenever anybody will give her a chance. She also learned some sewing, mostly by picking up a needle and thread and scraps of fabric and trying things. And she became a better photographer this year after helping out a lot taking pictures for this book. I'm sure there are many more things that they've learned—that's only the list we came up with over lunch at the park one day.

CHARLOTTE MASON

A lot of people love Charlotte Mason's approach. She advocates brief lessons that are finished by lunch. This leaves afternoons free for nature studies or outdoor play.

She also says that all learning should come from "living books", which basically means good literature. Instead of reading a textbook about wildlife, you find a book written by someone who is passionate about wildlife. To us,

this is common sense. A lot of kids books dumb things down to the point of being insulting. Reading good literature encourages reading, because it's good. It helps children to be good writers and well-spoken.

HOMESCHOOLING RESOURCES

If purchased new, curriculum materials can be expensive. Much of our material comes from the library. Public libraries don't often carry homeschooling workbooks but if you're studying from "living" books, there is a lot to choose from.

If you're looking for standard curriculum materials, try used book stores. We've found a lot there! We've gotten a number of homeschooling books through www.paperbackswap.com.

If you have more than one child, make copies of workbooks before you begin using them, so you won't have to buy them twice. Parents at our homeschool co-op also share a lot of material with each other. Through our co-op we found out about a curriculum library for homeschoolers. We found it was most useful for checking out curriculum we thought we might be interested in.

We spend about $100 to $150 per kid on curriculum each year, which is about half of that is for their math curriculum which is very difficult to find used.

LEARNING LIFE

One of the best parts about schooling at home is that the children are able to learn about real-life experiences by being involved in them.

My mother brought up a fantastic point one day. "It's just about everybody's goal to one day own a house," she said, "but school does nothing to help you along that path."

What if kids learned in school how to shop for a house, such as what to look for and what to be wary of? These days it is especially important to know how

to get a loan and how credit works. Home maintenance would be a wonderful thing to learn.

These are the kinds of things we could and should learn in school but we don't. Children who are schooled at home, however, have the opportunity to learn these things. If you're buying a house, you can involve your children. If you're plumbing, you can involve your kids. Whenever you're able, bring them in on the learning experience. Then it will be natural for them to look at a project and think, "I can do that!" rather than "Who should I call to do this?"

Having your children involved in your life is one of the most important and most fun (on most days) part of homeschooling. An interesting thing is that the learning goes both ways.

You'll find spending time with your kids to be very rewarding. Rachael talks about the huge sense of accomplishment she felt when the kids started reading and she had been the one that taught them. The main lesson is: don't be afraid to try. The first couple steps are the scariest and most difficult, but once you get past that it feels like the natural way to do things.

RESOURCES

Books:

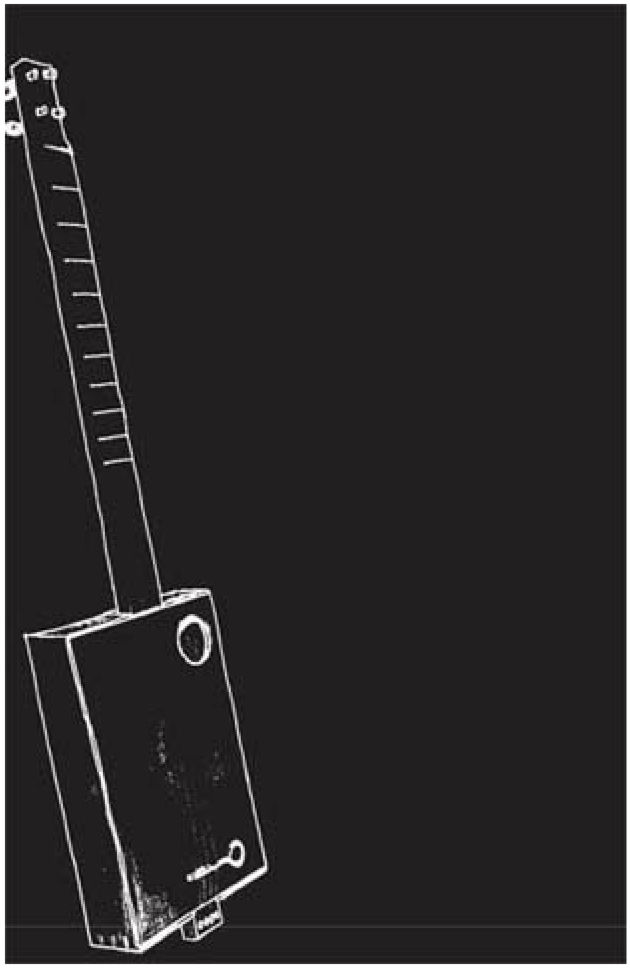
- The Child and the Machine by Alison Armstrong and Charles Casement
- You Can Teach Your Child Successfully: Grades 4-8 and other books by Ruth Beechick
- Charlotte Mason Companion by Karen Andreola
- The Unschooled Mind by Howard Gardner
- How Children Learn by John Holt
- Teach Your Own by John Holt
- Teenage Liberation Handbook by Grace Llewellyn
- Getting Started in Homeschooling and other books by Mary Pride

- For the Children's Sake by Susan Schaeffer Macaulay
- Discover Your Child's Learning Style by Mariaemma Willis M.S. and Victoria Kindle Hodson M.A.

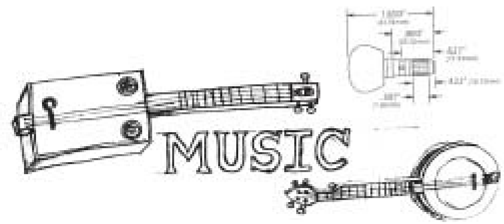
Curricula:
- Phonics Pathways
- Prairie Primer (unit study based on Little House on the Prairie Books)
- Explode the Code (phonics book series)
- How to Tutor by Samuel Blumfield
- Konos (unit studies on everything)
- Complete Handbook of Nature Study by Anna Botsford Comstock
- Spelling Power
- Primary Language Lessons and Intermediate Language Lessons by Emma Serl
- Five in a Row and Beyond Five in a Row (literature-based unit studies)
- Saxon Math
- The Story of the World by Susan Wise Bauer

Our final recommendation is a homeschooling mainstay, the Rainbow Resources Catalog. It's full of curricula, games, educational toys, and other homeschooling resources that can be difficult or impossible to find elsewhere.

MUSICAL INSTRUMENTS



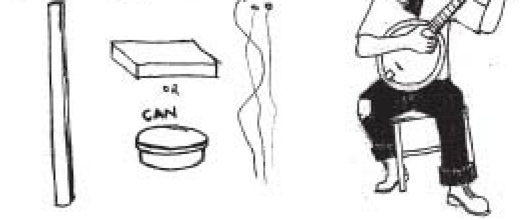
MUSIC



When I started working on this book, I had no intention of including instructions for building musical instruments. Playing music didn't have a place in my life or mind. Many years ago I used to play guitar but I was never particularly good at it. At least, I didn't think so. I never got further than strumming a few simple songs. Eventually I decided that since I was never going to be exceedingly good at it, there was no point in continuing. I focused my efforts on writing instead.

Perhaps that's worked out well for me, but a few years back I got a bit of a hankerin' to play the banjo. Rachael plays a lot of music and I wanted to play with her, so I bought a banjo. I tried to teach myself to play but, again, was never as good as I wanted to be, so I gave up.

Well, something sparked my interest in playing banjo again. There's a pretty good chance it was listening to 16 Horsepower. I didn't have the cash for another banjo, but I had a vague recollection of a hub-cap banjo a friend of mine had made and plans I'd once seen in a zine. I figured if I built my own banjo, I would be more inclined to play it. More importantly, I decided that I didn't need to be good to enjoy playing.

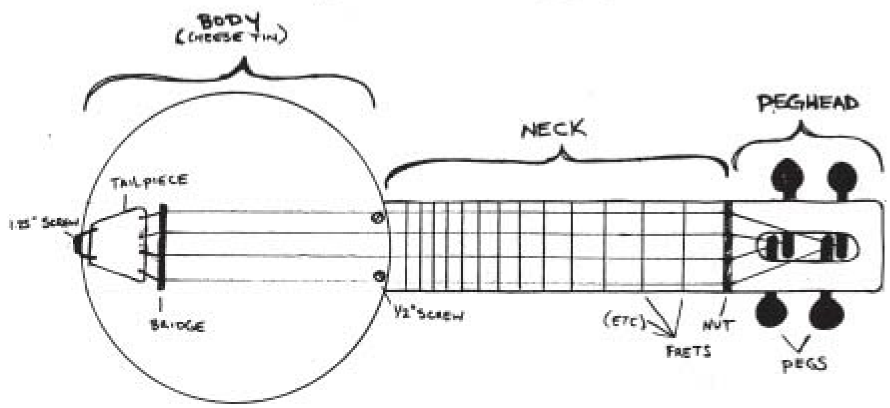


The first time I tried banjo, I was having trouble with finger-picking and threatened to start strumming chords. Rachael said "If you're not going to fingerpick, what's the point?" Years after selling my old Washburn, I decided that the point was that I enjoyed playing music. It doesn't matter if I don't play banjo like everybody else does. If I want to build a banjo and strum chords, what difference does it make? It doesn't matter if I fm never good enough to play in a band or even on a street corner. So it was decided! I'd build a banjo and play it because I enjoy playing.

In the search for information on how to build a banjo, I started running across books and websites with schematics on a whole plethora of instruments. It had never occurred to me to build a banjo out of a cookie tin or a guitar from a cigar box. I'd never considered playing, let alone building, a dulcimer. And aren't ukuleles just toys? But ever since I've started making them, I've been obsessed.

The point is, don't gloss over this section because you're not a musician. You don't have to be a "musician" to enjoy making music. It is really exciting to play an instrument you made yourself, even if you don't play it all that well. There's a huge sense of accomplishment in creating music on something you made! Plus, once you get over that initial embarrassment of not knowing how to play and then start playing for fun, you might find that there is a good musician hiding in you! If not, who cares? That's not the point.

canjolele



THE CANJOLELE

Recently I decided to pick up another project I've been meaning to tackle—the "canjolele", a ukulele/banjo hybrid made using a cookie tin for the instrument's body. First I picked up a couple cookie tins at the thrift store for \$1.68 a piece. Then I got a hold of a 3/4" × 1.5" × 2' piece of red oak for \$1.58, which is perfect because the neck needs to be 1.5" wide.

BUILDING THE BODY

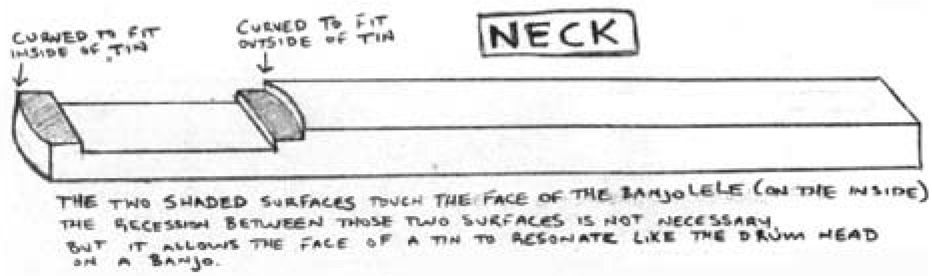
First, set the cookie tin on top of the oak neck so that the neck is centered across the middle of the tin. Then mark the curve of the tin on it. One of these

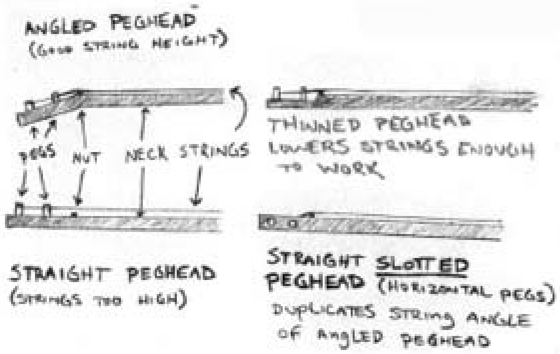
will have to be shaped to fit the inside of the can and one needs to be cut to fit the outside. The neck of the instrument needs to be exactly level with, or a hair taller than, the cookie tin (including the rim) or the strings will buzz. The rim of the can will probably be about as thick as a yard stick (1/8"), so lay the neck on the table with the yardstick right next to it and trace a line down the side of the neck. Now you need to remove that 1/8" of wood in the shape of the tin so the neck can slip into the tin and still be tall enough to clear the rim.

Before you do that, you need to trace the neck onto the tin so you know what size hole to cut. In order to keep things simple, use the bottom of the tin as the front of the canjolele. Otherwise, the tin and the lid will have to be cut and the neck will have to be cut to fit the curve of the lid. Lay the tin down on the table with the lid up. Put the end of the neck right next to the tin, also laying flat on the table, and trace it onto the tin with a pencil. You should orient the neck so that the seam of the tin will be on the bottom of the canjolele when it is finished.

After that, take a utility knife with about ¼" of the blade sticking out and cut along those lines. Don't cut along the bottom (next to the rim) but instead, fold the rectangle of tin into the can. Now the hole is slightly smaller than the thickness of the neck, so the neck has to be trimmed to fit that hole. Use a rasp to remove the majority of the 1/8" of wood and to curve the end of the neck to fit the inside of the tin. The tricky part is that the curve that has to fit the outside of the can. Don't get too close to that with the rasp. Once you have most of the wood cleared out of there, use a very small, very sharp chisel to remove the wood at the curve.

For delicate work like this, use your hands to do the work of the hammer, simply by pushing the chisel where it needs to go. When that's done, slip the neck into the hole in the tin. If the neck is too long or if it's a hair lower than the rim of the tin, it might need a little trimming.





A chisel is made so that you can almost always get a straight cut. It's only beveled on one side, so the back of the file comes straight down all the way to the tip. The other side is beveled to the tip. If you're trying to make deep cuts, or if you're cutting around a convex curve, use the chisel with the bevel facing up. If you're trying to make fine cuts, like leveling out the bumps in a piece of wood, lay the chisel on the bevel and push it along. If you try to cut with the bevel facing up, the natural tendency of the chisel will be to dig deeper into the wood because that's where it's pointing (you can't hold the chisel level to the wood with the bevel facing up). This is also the way to cut concave curves or in other confined spaces.

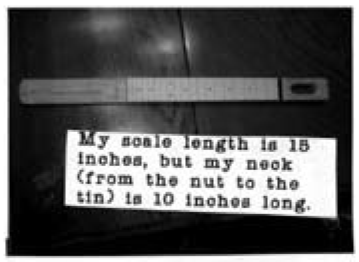
Now, you don't want the neck of the canjolele to be pressed against the tin the

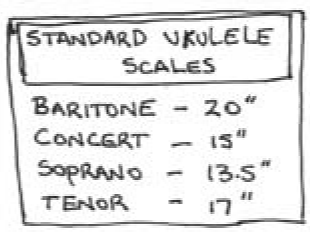
whole length of the can (because you want the tin to resonate). Draw straight lines across the neck about an inch in from both curves, then cut that area out with a rasp. Once you remove the majority of the wood with the rasp, finish up the edges with the chisel. Now the neck should fit inside the can and still allow the tin to “ring.”

Next, lay the fret template on the neck and mark where the nut will be. I searched online and found a template for a concert ukulele neck that printed out full-size. The concert ukulele has a scale that is 15” long, which means that the distance between the nut and the bridge is 15”. I like my bridge about 2-3” from the edge of the tin. Mark the neck where you want the bridge to be, and then measure 15” from there. That’s where your nut will be.

Once you know where the nut is, you know where the head starts and where the tuning pegs need to be. I used pegs left over from a broken guitar. Hold the tuning pegs about where they’d go on the head and mark how long and wide the hole will have to be. The hole needs to be wide enough to access the string holes on the pegs, and long enough that the tuning knobs aren’t too close together. Then mark a rectangle on the neck to show where the hole will be. I measured the width of the rectangle and it was about 11/16”, so I decided to drill a hole in both ends with a 5/8” bit and then use a coping saw to cut out the rectangle. The 5/8” should leave enough room for sanding or filing the inside of the hole.

Then, measure out where the center of the bit will be and put a little divot to make sure that the bit will stay where it needs to be, and drill the two holes. To keep the wood from splitting on the back side, I put it on top of a scrap 2x4 and drilled through the neck and into the 2x4. When I was making mine, it looked to me like I could drill one more hole in the middle of those two and have most of the material removed. So I did that. The rest of the material I removed with a chisel.





Next, shape the neck a bit. Mark on the back where the nut is (where the peghead starts) and where the neck goes into the can. Using a rasp, round off the back of the neck between those two lines. Once you have it shaped you can use sandpaper to smooth it out.

DRILLING HOLES FOR THE TUNING PEGS

Once you’ve done that, lay out where the pegs will be on the peghead and mark where the holes need to be drilled in the side of the peghead. Make a divot where the center of the hole should be then drill the hole, making sure to keep the bit perpendicular to the neck. If you need something to hold the neck while you drill, you can wrap the neck in clean rags and clamp it in a vice. Try to clamp pieces of board inside the center hole in the peghead to keep the wood from chipping when the bit comes through (alternately, the peg holes could be drilled before you slot the headstock). Once you have the holes drilled, check to make sure the pegs actually fit. If the holes aren’t quite long enough for the whole peg, use a drill bit for metal to lengthen the peg holes into the other side of the peghead. That will make a nicer looking divot than the wood bit will.

Now mark the frets. Cut out a printed fret template and tape it to the neck. Starting at the nut, go down the template marking where each fret will be on the side of the neck. Then use your square to mark a perpendicular line across the neck where each one of the lines will be on the side of the neck.

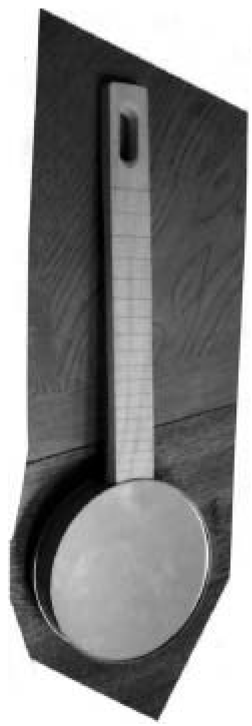
★ FRET LAYOUT ★

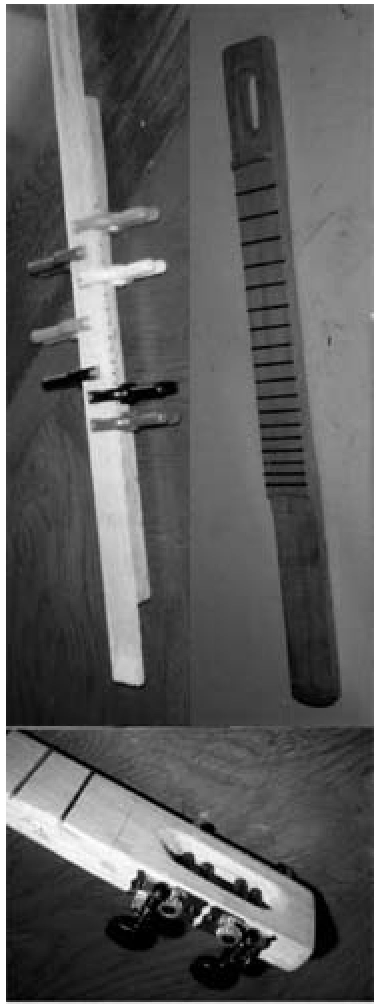
how to figure out where your frets go
(without a template)

If you can’t find a template for the length of neck you want, there’s a way to create your own fret template. The first thing you need to know is the scale length. This is not the length of the neck. My scale length is 15”, but my neck (from the nut to the tin) is 10” long. Scale length is the active sounding length for an open string, from the bridge to the nut. To figure out where your frets go, you divide the scale length by 17.817. That tells you where your first fret goes in relation to the nut.

This is much easier to do if you do your measurements in millimeters rather than inches. So for example, my scale length is 380 mm. I divide that by

17.817 and come up with 21.3-my first fret should be 21.3 mm from the nut. To determine where the next fret should be, subtract the length to the first fret from the scale length and divide that by 17.817. For me that means subtracting 21.3 from 380, dividing that by 17.817 which gives me 20.1. This is the distance from the 1st fret to the 2nd fret. However, rather than measuring from the 1st fret, it's best if you add the distances together and measure from the nut. So I would add 21.3 and 20.1 and come up with 41.4.



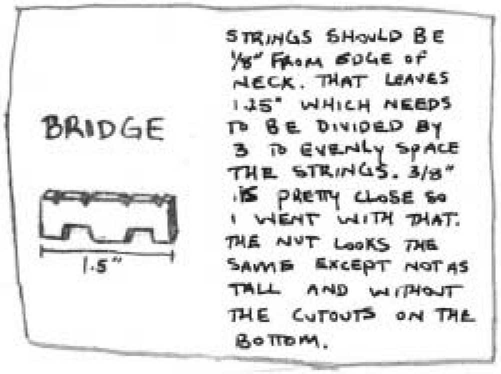


Your second fret should be 41.4 mm from the nut. This is a better method than measuring from the previous fret because if you make a mistake on the previous fret, every fret after that will be off. If you always measure from the nut, you don't compound your mistakes. For the 3rd fret, you subtract the distance from the nut to the 2nd fret and divide that by 17.817. For the 4th fret, you subtract the distance from the nut to the 3rd fret and divide that by 17.817. You continue doing this until you get as many frets as you want. Again, it's better if you calculate all your measurements rather than measuring from fret to fret.

For the frets, I used wire I'd saved from a magazine binder and then cut slots that the wire would fit into. I chose to do it this way because it's easily replicated without specialized tools. Fret wire is very easy to install, works

better and lasts longer. Wire has a tendency to work itself free after a while and will then need to be re-glued. If you want to use traditional fret wire, I’ve covered that in *Cigar Box Guitar*. However, fret wire will usually have to be specially ordered whereas round metal wire can be easily found (e.g. bicycle spokes). You can also substitute round toothpicks for the metal wire, though they don’t last as long. This style of fret is used by many do it yourselfers, especially for their first instruments.

To score the lines that the frets will run along, use the square again and a utility knife. Once you score the line, use a hacksaw with fine teeth to cut a slot but don’t cut deep; start out slow and careful until you have a little groove to keep the blade from slipping. Go back and forth a couple more times and then it should be done. After that, use a small triangular-shaped metal file to widen the top of the slot. Then cut a piece of your fret wire as wide as the neck and try it in each of the fret slots. You want the wire to sit about halfway in the slot. So try the fit and if it sticks up a little too far, file the slot a little wider/deeper. Once you get all of those slots the way you want them, use lineman’s pliers and start cutting the fret wire to length, using the first fret you cut to measure the rest of them. Once they’re all cut you can use a metal file to clean up the ends. You may want to practice this on a scrap piece of wood before actually doing it on your neck.



GLUING DOWN THE FRETS

Next, glue down the frets with epoxy, using a toothpick to dab a tiny bit of epoxy in one slot at a time. Make sure each fret is level across the neck and make sure the frets are all level with each other. Then use a piece of lathe and a bunch of clamps to hold it together while it dries. After they've dried in place, you can use sandpaper to clean up any residue from the glue. Although the epoxy cures in five minutes, it's not fully set for 24 hours, so keep the neck clamped for the full 24 hours.

Now it's only a matter of screwing the neck to the tin, attaching the tailpiece, and adjusting the height of the bridge and nut to make sure the action isn't too high. Then, screw the tuners on. There isn't much to it: slip the tuning peg into the hole, making sure everything is straight, and drive a couple tiny screws into the peghead. Predrilling the holes prevents the tiny screws from breaking when you install them.

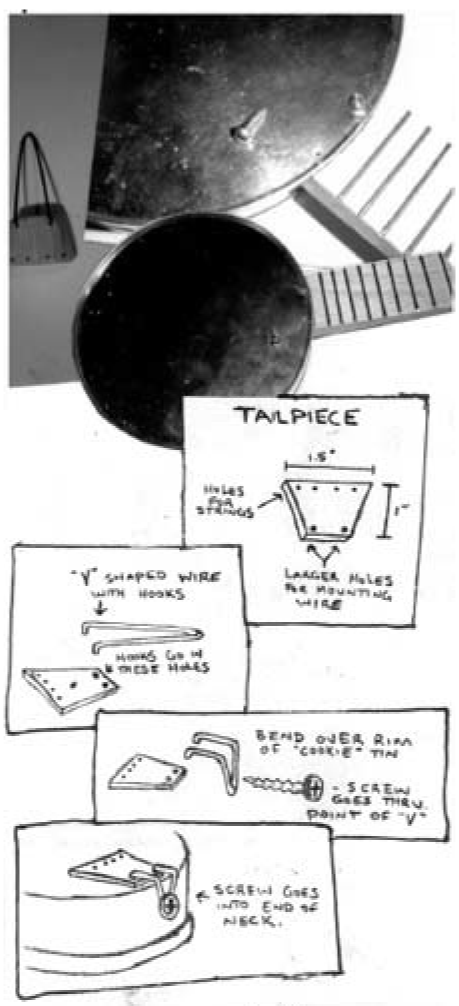
BRIDGE, NUT, & TAILPIECE

While you're waiting for the glue to dry, you can work on your nut, bridge

and tailpiece. If you've got wood left over from your neck, that will work fine. The nut should be the width of the neck and about ¼" × ¼". The bridge should also be the width of the neck, ¼" thick and about 3/4" tall. The tailpiece is again the width of the neck, ¼" thick and about 1" long.

PUTTING IT ALL TOGETHER

Now that you have all the pieces, it's only a matter of putting them together. First, slide the neck into the body. Hold the neck in the body while you pre-drill holes for the little screws. On mine, I decided to put two screws right next to the rim on the front of the body where the neck enters. These were small screws about ½" long. Then I pre-drilled a hole right where the end of the neck meets the inside of the tin. This screw was probably 1.25" long and had a pretty large head, which I planned to use for holding the tailpiece on.



To attach the wood tailpiece, use a piece of the same wire that you used for the frets. Bend it into a V-shape and then bend hooks on the end and drill holes in the wood tailpiece for the hooks to go into. Then, put a bend in the V where it bends over the rim of the body.

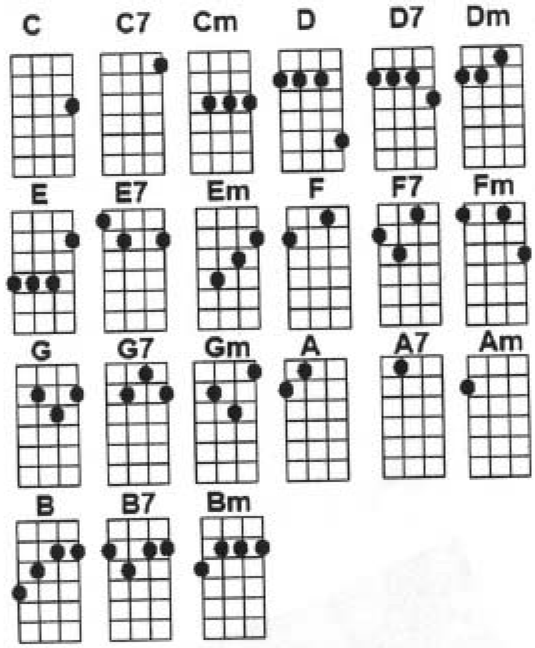
Drive the screw into the end partway, slip the wire from the tailpiece over it and tighten it. I marked where the bend needed to be and then took it back off, bent it with needle-nose pliers, put it back on and tightened the screw. Now the neck and tailpiece are both attached to the body. All that's left is getting the strings on and making sure the bridge and nut aren't too tall. Try putting a couple strings on and then slipping the nut and bridge under them. If they're too high near the nut, take off the nut and sand it down a bit. If the nut is still too high you can sand it some more or cut the notches for the strings a little deeper. Same for the bridge. If the strings are too high, sand it down a bit. Once you get the nut the correct height, glue it in place. The edge of the nut should be at the line you marked for the nut, so that the strings begin to touch it at that line.

ALMOST THERE!

Next, tighten all the strings and play each fret on each string to see how it sounds. On mine, the bottom string buzzed when you played the third fret. I could see that the fret it was buzzing on was a little higher than the others so I used a knife to knock it out, filed the notch a bit deeper and re-glued it. Rather than clamping the whole neck, I used a clamp on each side of the fret.

When everything was finally done it was a lot of fun to play and sounded pretty darn good—especially considering it cost only a few dollars to make. Now get out there and make your own.

Ukulele Chords
(for Standard G C E A Tuning)



BUILDING A CIGAR BOX GUITAR

Some of the details of this build are going to be pretty similar to the cookie tin canjolele build, so I may refer to that rather than writing the same thing twice.

Materials:

- 1”×2”×3’ piece of wood
- cigar box (or other wood box)
- tuners
- some screws
- strings

PREPARE THE CIGAR BOX

For this guitar, I decided to go with only 4 strings. A 1x2” piece of wood (which actually measures 3/4×1.5”) is the perfect width for 4 strings. If you want more strings, you’ll have to buy a 1x3” piece of wood and narrow it. However, more strings can possibly bend a neck that doesn’t have some sort of internal support (like a truss rod). If you’re not using a 1x2” piece of wood for the neck, make your own adjustments.

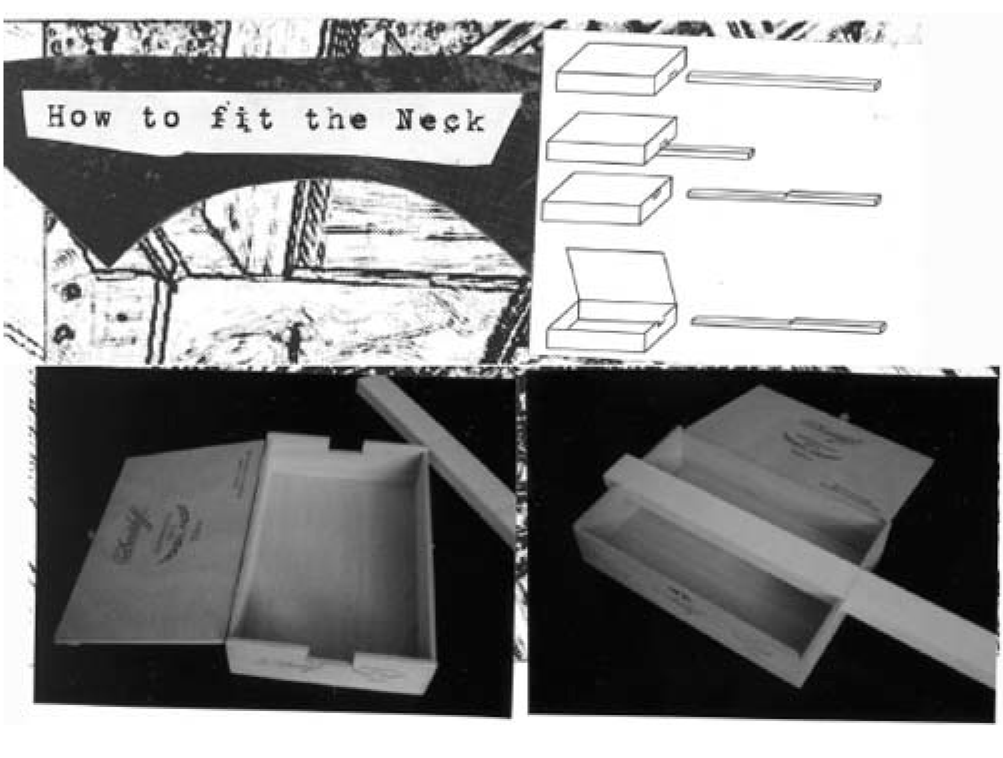
Lay the end of the neck next to the box where you want the neck to pass into it. Trace it onto the box. Mine was centered lengthwise on the top (the side that opens.) On others, I’ve done it on the bottom so that it could still be opened when finished. That makes for easier access to the innards. It’s sort of a tossup. The top of box usually looks nicer, but if you use that for the front, it

makes it difficult to access the insides of the guitar…which shouldn't be a problem, as long as you get everything right the first time!

Now cut barely inside the lines you traced. Cut the hole barely big enough for the neck to make a pretty tight fit. On mine I decided to go with a "neck through" design, which means the neck goes all the way through the box and comes out the other end. So I cut matching holes on each end of the box.

FIT THE NECK

Once you get the hole cut in the side of the box, you'll need to thin the portion of the neck that will be on the inside. The top of the neck needs to be even with or a little higher than the "top" of the guitar (whichever side of the box you choose to be the top). Mark the length of the cigar box on top of your neck piece, then mark the thickness of the box "top" down the side. You'll want to remove that much wood so that the neck will slide into the hole. I did this with a rasp on my first instruments, but these days I've been doing it with a band saw (which makes this extremely easy and fast). I covered this pretty exhaustively in the canjolele article, so if you don't quite get what I'm talking about, read more details there.



When you start getting close, constantly test fit the neck to make sure it fits right. Once you get it to fit correctly, move on to the next steps.

Now you need to figure out how long your neck will be. So determine where your bridge is going to be (one-third the length of the box from the end is a good spot) and then measure from there to the nut. In general, 25.5” is a common length for acoustic guitars. I went with 24.5” on this one. Once you know what length scale you want, mark where the nut will be.

LAY OUT YOUR TUNERS

On my last build, I cut a slot for guitar tuners. This time, I bought some ukulele tuners which mount differently. I had to thin the peghead so the pegs wouldn’t stick up too high. With ukulele tuners, this actually lowers the whole peg. With most guitar tuners, this allows the string to be wound farther down the peg, which pretty much does the same thing. Another option is to mount the tuners “upside-down” with the pegs sticking out the back of the peghead. In this case, drill angled holes for the string to pass through. It looks different, but works fine.

Whichever way you do it, make sure you take into account how much room the knobs are going to need to turn. I failed to take that into consideration when I laid out my tuning pegs the first time and I had to drill two additional holes to make them all fit.

SHAPE YOUR NECK

If you buy 1x2” sticks, this is pretty simple. I used a rasp to round off the back

of the neck where it'll be held, the section between the peghead and where it enters the box. I didn't take off too much, only enough to make it comfortable to hold. Once I got the shape I want, I went over the whole thing with sandpaper.

INSTALL FRETS

I've already gone over fret placement in the cookie tin canjolele piece. One thing I didn't mention there is that you can find fret placement calculators on the Internet. Search for "fret calculator" and you'll pull up a few of them. However, it's really not that difficult to figure out fret placement with the "rule of 18" formula that I explained in the canjolele piece.

With this guitar, I decided to use actual fret wire. It's pretty easy to use!

After marking frets on the neck, use a dovetail pull saw to cut slots. A pull saw cuts on the pull stroke rather than the push stroke, making it easier for detail work. It's also thinner, which is important because the fret wire won't stay put if your slot is too wide. Instead of using measurements, I laid the fret wire tang against the saw to see how deep the slot needed to be. The tang went about halfway up the teeth, so I cut until the sawteeth were about halfway into the wood.

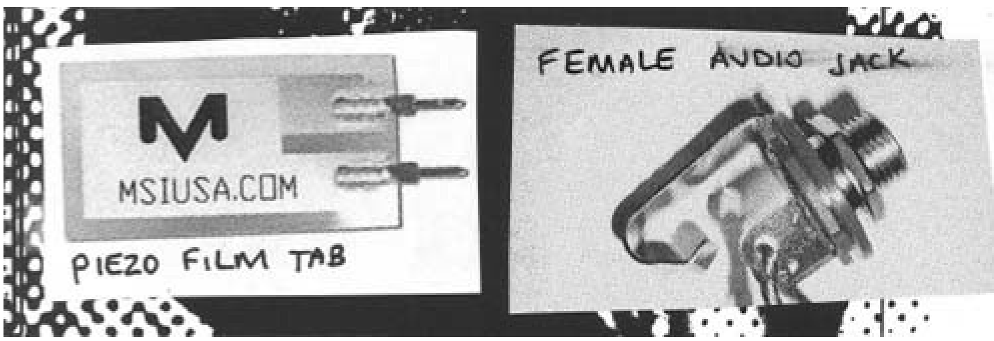
The main thing is to take your time. If you don't get the fret slots straight, that will cause problems. And if you get a little careless and slip, you'll mar your "fingerboard".

Once you get all your slots cut, lay the fret wire on top of the slot and cut it to length. I use a nipper-type wire cutter that is very similar to "professional" fret cutters. Since I don't have expensive fret files, I shape the ends of the frets before I put them on. I file the tang at a bit of an angle, so it won't stick out from the side of the neck if it's a little bit long. I also round off the crown (horizontally and vertically) and make sure that there are no sharp edges.

Lay the fret wire in the slot to make sure it looks the right size. If it's a little

long, file off a little more. If it looks good, I'll put the tang into the slot far enough so that it doesn't move. Then I put a scrap block of wood on top of the fret and use that block to hammer the fret all the way into the slot. The bottom of the crown should rest right on the fingerboard. The barbs on the tang will hold the frets in place. There's no need for glue!

I decided I probably wouldn't use more than 9 frets, so that's as many as I put on. This ends up being about 13.5" of fret wire, which cost less than $2.



CUTTING A SOUNDHOLE

If you want a little more volume from your guitar, cut a soundhole (or a few). Since the neck normally runs down the center of the cigar box, cutting a hole in the center (like a standard acoustic guitar) doesn't make much sense if the neck is going to cover half of the hole. I figured that cutting holes above and below the neck is a better idea. Some f-holes would have looked good (or any number of other interesting shapes) but to make things easy I decided to go with a round hole. I found a place in one corner where I could cut a 2" hole without cutting out any of the text on the box. I marked the center of the hole and cut it out with a hole saw (a round saw blade for electric drills).

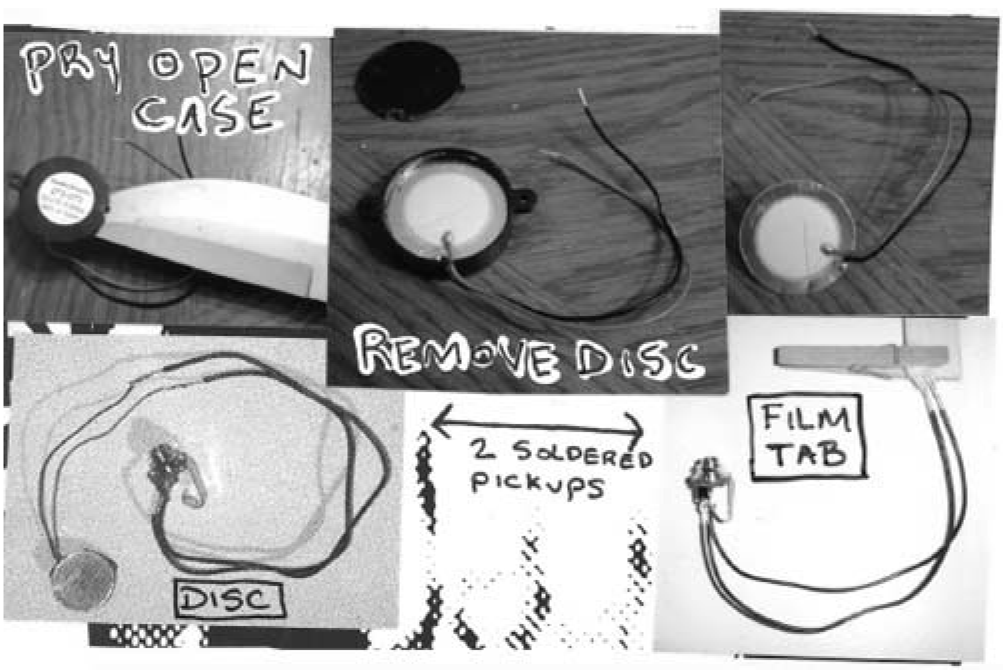
CREATING A TAILPIECE

Now you have to figure out something in lieu of a tailpiece. On my canjolele I used a violin-style tailpiece. On this guitar I used the "neck-through" style, putting screws in the part of the neck that sticks out the end and attaching the strings to it. I fm always getting plain end strings, so I need something to tie it to. You can go as fancy or as simple as you want. Even a triangular piece of

leather with holes for the strings will do the trick. If you get ball end strings, all you need are holes to put the string through and the ball will hold it in place.

MAKE YOUR OWN PIEZO PICKUP

If you want to be able to amp your guitar, there's a pretty simple and cheap way to build your own pickup. I hadn't planned on putting one in this guitar, but when I told my dad that I was building it for him, he mentioned that he might want to play it at church. All you'll need is a piezo tab or buzzer, a ¼" phone jack and some wire. From what I understand, piezo buzzers are in everything: kid's toys that make noise, those music-playing greeting cards, some computers, car alarm remotes, along with alarms and buzzers of various types. But could I find one when it was time to make my pickup? Nope!



So I ended up buying some piezo film tabs. They cost about twice as much as new piezo buzzers, which means they cost me $2 each. I also had to buy a ¼" female audio jack because I couldn't find anything to scrounge one from. That cost $3 for a 2-pack. All I had to do was solder some 18-gauge wire from the tabs on the piezo film to the tabs on the audio jack. I later found out that

when using piezo film tabs, you should shield both the tab itself and the jack by wrapping them in copper tape. I didn't do this, so my guitar has a bit of a hum (a 60 cycle hum).

When soldering the piezo element, do it as quickly as possible because it's sensitive to heat. If your piezo already has wires attached, this makes things much easier. Piezo film tabs also have little connectors to solder. If you have a piezo buzzer without wires attached, one wire needs to be soldered to the center and the ground wire needs to be soldered to the metal ring on the outside.

If you can't seem to scrounge one from anywhere, piezo buzzers (also called piezo tranducers) can be purchased at some electronic stores. They may come in little plastic cases. You'll want to pry open that plastic case and remove the little metal disk inside. This is the piezo! Where you're using a film tab or disk, you should always try to isolate it from the air. This is usually accomplished by sandwiching it, such as between the bridge and guitar top or between the guitar top and neck.

Piezo elements are made from two conductors separated by a layer of piezo crystals. When voltage is applied, the crystals cause the metal conductor layers to bend. When an audio signal is applied, they produce sound waves. This is how they're most often used, but what's interesting is that it also works the opposite way. When sound waves are received by the conductors, they cause the piezo crystals to produce electrical signals that can then be run into an amp. In order for them to work well, they need to be in a place to receive the vibrations produced by the instrument. One of the best places is under the bridge. I put mine inside the box between the neck and the top of the box, and directly under the bridge. In order to make sure that it was held tightly between the two pieces of wood, I glued it to a small piece of high density foam rubber (cut from the corner of my one and only mouse pad) and then glued that to the neck.

Now, figure out where you want your pickup jack to be, drill a hole there and then put it in. The nut goes on the outside to hold it in place. To test your piezo, plug in your guitar and tap the box. You should hear the tap coming from the amp. Alternately, you can use the fishing line trick (mentioned below) to test the sound while you're testing the action.

Elsewhere, I've written a piece on how to wind your own "electric" style pickup if you'd prefer to try that.

FINAL ASSEMBLY

You're getting very close now! All that's left is to assemble all your pieces. Put your tuners in. Put your neck into your cigar box. My neck was such a tight fit, I almost didn't screw it on at all but I ended up deciding to run a couple small screws through the top of the cigar box and into the neck.

Now, figure out what you're going to use for your nut and bridge (if you don't know what these are, check the canjolele drawing). For my bridge, I used a ¼" eyebolt. This works well because it lays flat and the eye keeps the bolt from rolling. Also, using bolts for the bridge and nut is handy because they already have slots for the strings. For the nut, I used a slightly smaller stove bolt. It was the smallest diameter screw I could find that was at least 1.5" long. It was actually a little too large, so my action (the distance between the strings and the neck) was too high. I used a rat tail file to fix this by making a channel for the nut to sit in. This brought the action down to an acceptable level. Once I figured out which size nut and bridge to use, I used a couple tiny squirts of hot glue to hold them in place.

One good way to figure out how high your strings are going to sit without putting them all on is to use a length of fishing line. It's actually pretty much the same as plain nylon guitar strings. I actually considered using fishing line for all the strings, but I couldn't find fishing line thick enough for the low strings.

Then I put the strings on and tuned the guitar. I used nylon strings, but you should be able to use steel strings on a four-string guitar. This build was tuned like the bottom four strings of a guitar (D-G-B-E). This way, chords that you know on guitar will transfer right over. You use the same fingering, except that any fingers that were on the top two strings don't do anything because those strings aren't there.

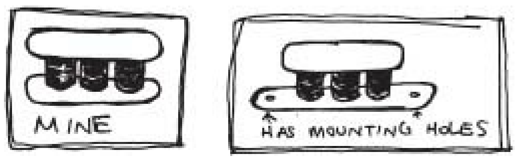
Okay, enough reading…build and then play!

WIND YOUR OWN GUITAR PICKUP

I wanted to try something more complicated than prying apart a buzzer and using the insides as a pickup. I wanted to wind my own pickup, like the ones you find on electric guitars. They're almost as simple as a piezo pickup, only a little more time consuming.

But wound pickups will only work on steel strings. Steel strings change the magnetic field of the magnet(s) inside the wound pickup. The wire wrapped around the magnet picks up the changes in the magnetic field. Run through an amp, you get the sound of your strings vibrating.

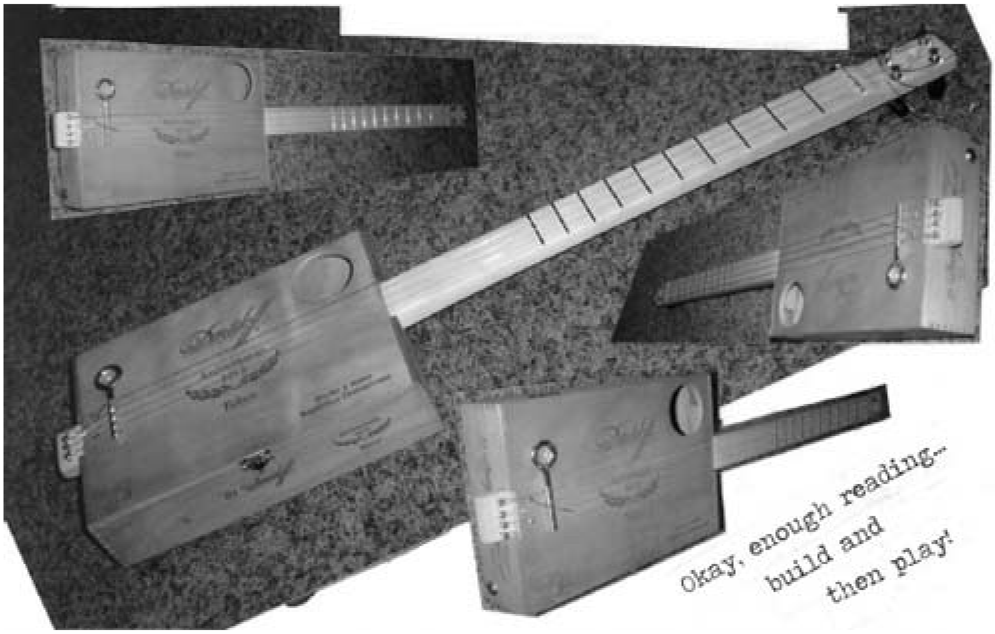
There would be no difference in sound between an electric and an acoustic guitar with this type of pickup, because it doesn't pick up the vibrations that are going through the body of the guitar—it only picks up the vibrations of the strings.



A piezo, on the other hand, will pick up the sound of whatever is vibrating. If you tap the body of your guitar, it will pick that up. If you tap the body of an "electric" guitar with magnetic pickups, it won't pick it up, unless it causes the string to vibrate.

I went down to this little oddball surplus store that carries all kinds of weird things and got four little cylinder magnets and 200' wire. The wire looks sort of orange but there is similar wire in red. The color is the coating on the wire but it doesn't have a thick plastic coating like most wire you see. It was marked as #36, which means 36-gauge.

It was so thin that the machine they use to wind wire (and count the number of feet at the same time) kept breaking the wire, so the guy had to crank it exceptionally slow to get the full 200' without breaking it. The magnets cost me 75 cents each, and the wire cost 2 cents a foot. So I ended up spending $7 on parts.



I cut two pieces of wood about 1.5" wide long and about 3/4" wide—that's the width of the neck on my cigar box guitars, so all the strings would fit over the top of it.

FOR THE BEST SOUND YOUR PICKUP SHOULD BE AS CLOSE TO THE STRINGS AS POSSIBLE

These were cut from scrap leftover from cutting a guitar neck—about 1/8" thick.

I rounded off all the corners so they looked sort of like a long oval. I'm planning to glue it down when I mount it in a guitar, but if you want to screw it down, you'll want to make the lower piece long enough to put a screw on each end. You can also use non-conductive materials like plastic or even cardboard.

The next part is the trickiest. Glue those magnets between the two pieces of wood. This wouldn't be so difficult except that all the magnets have to face the same direction—the north or south sides all have to be up.

Magnets don't naturally sit like that—opposite poles attract. So magnets sitting side by side will naturally set themselves up to alternate north-south-north-south.

To glue all the magnets facing the same way, glue them one at a time with 5 minute epoxy. Clamp each magnet down until the glue dries so it doesn't move because of the polarity.

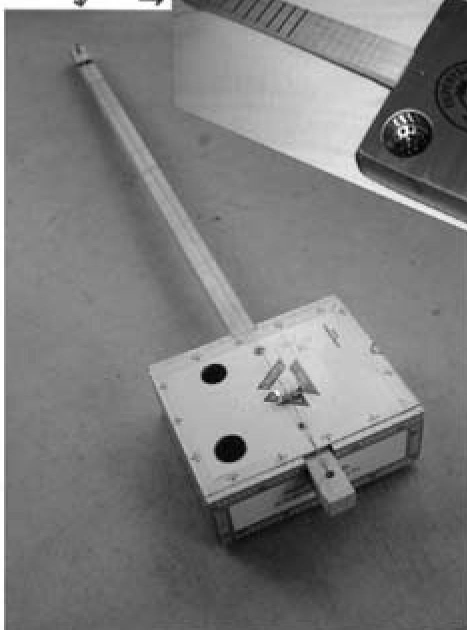
I glued down each end before the middle. Be careful if you try that. While trying to get the middle magnet in place, the other two actually shot it across the room.

Generally folks like to have one magnet for each string, but I couldn't fit all four, so I went with three. Once all the magnets are glued to one side, put epoxy on all the other ends and put the other piece of wood on top. Clamp this together and add some extra epoxy where the magnets met the wood. Leave it clamped for a few hours while the epoxy cures.

Next, wrap the wire around the magnets. Wrap by hand, leave about 3-4” of wire hanging out and start winding around the magnets. It’s pretty time consuming because it’s sort of like trying to wrap a 200’-long hair around a spool. It wants to get tangled and it tries to kink on you, so occasionally you have to stop and try to prevent the kinks from forming, or untangle the skein of wire.

MORE CIGARBOX INSTRUMENTS

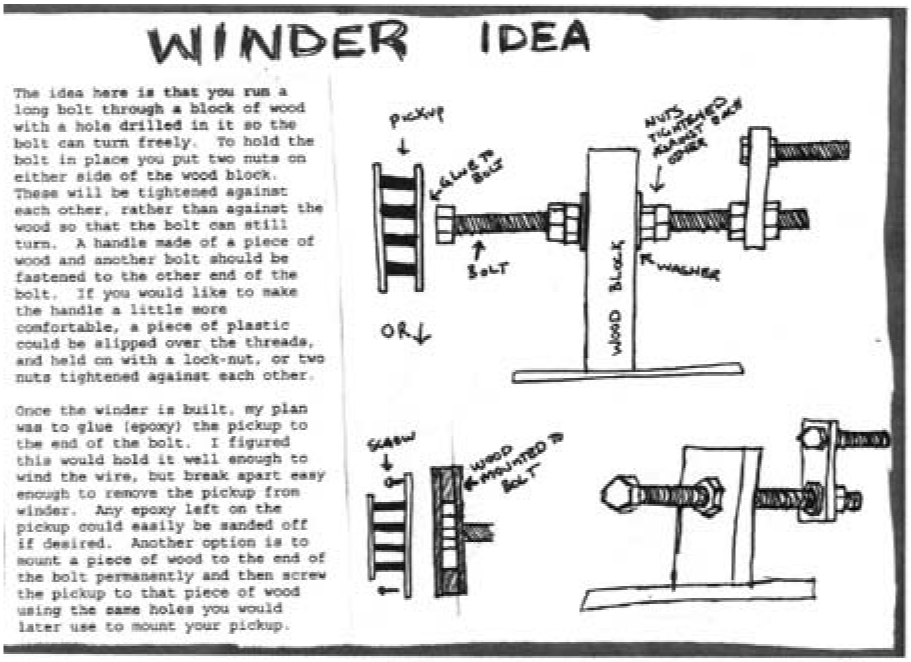
BOTH OF THESE USE ZITHER PIN TUNERS ↓ →



← THIS IS A ONE STRING DIDDLEY-BOW MY DAUGHTER ESTHER MADE

THIS IS THE TYPE OF BRIDGE USED ON BOTH OF THESE "GUITARS"

Another way to make a bridge



WINDER IDEA

The idea here is that you run a long bolt through a block of wood with a hole drilled in it so the bolt can turn freely. To hold the bolt in place you put two nuts on either side of the wood block. These will be tightened against each other, rather than against the wood so that the bolt can still turn. A handle made of a piece of wood and another bolt should be fastened to the other end of the bolt. If you would like to make the handle a little more comfortable, a piece of plastic could be slipped over the threads, and held on with a lock-nut, or two nuts tightened against each other.

Once the winder is built, my plan was to glue (epoxy) the pickup to the end of the bolt. I figured this would hold it well enough to wind the wire, but break apart easy enough to remove the pickup from winder. Any epoxy left on the pickup could easily be sanded off if desired. Another option is to mount a piece of wood to the end of the bolt permanently and then screw the pickup to that piece of wood using the same holes you would later use to mount your pickup.

NOT SURE IF YOU'LL BE ABLE TO SEE IT, BUT THIS IS THE TANGLED SKEIN OF WIRE I'M WINDING ONTO THE PICKUP.

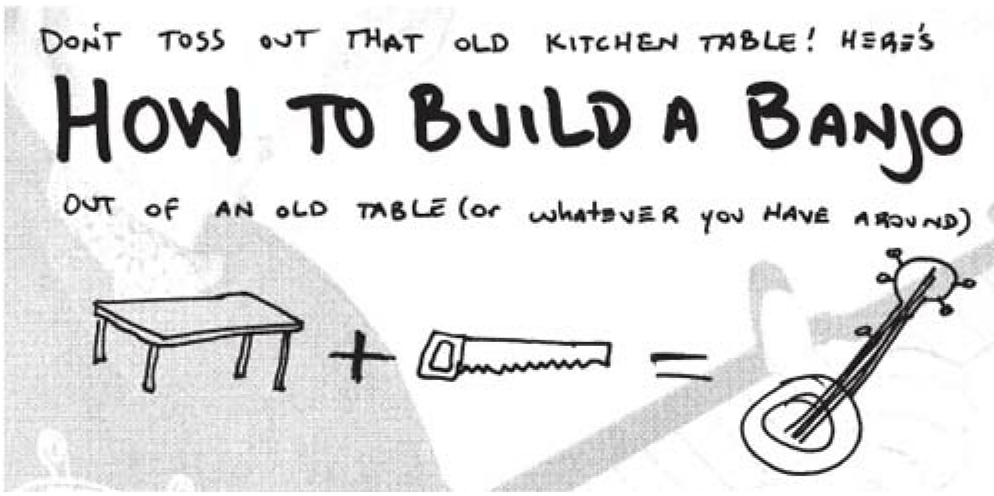
If you buy your wire on a spool and want to try out a winder, here's an idea I came up with for a pickup winder.

The wire used for professional pickups is even thinner, but you can try wire that's not quite so thin. Keep in mind, the more times you wrap the wire around the magnet, the more sensitive your pickup is going to be.

Once you get done wrapping, leave 3-4" on the other end hanging out and wrap a couple layers of electrical tape around the wire to hold it in place.

Now you can try it out. Using a razor blade, scrape some of the coating off both ends. Solder a couple lengths of 18 gauge wire to those leads, and then hook it up to a ¼" jack like you would a piezo pickup.

Make a place where it fits under your guitar strings, and plug it in. If you made a mount for it, you could use this in the sound hole of a traditional acoustic guitar. For the best sound, your pickup should be as close to the strings as possible.



BANJO

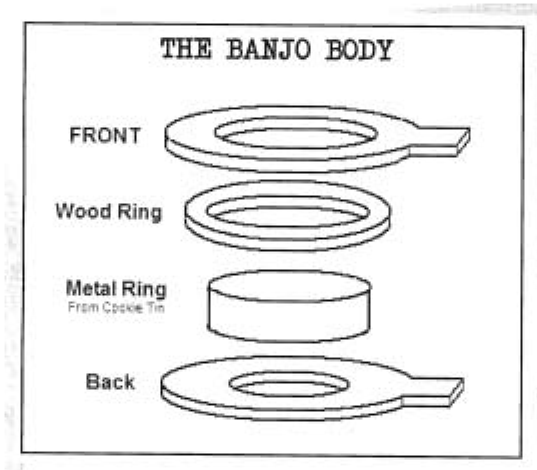
After finishing the canjolele for Rachael, I decided to build myself a banjo. I had originally planned on building a cookie tin banjo, but decided to try something different and do sort of a mountain-style banjo.

The first thing you need to do is find some wood. I found a broken table for $3 at a church sale. I ended up using 1 leaf to build the body. My wood was about 7/8" thick. You'll want a piece of wood about 12" wide, at least 3' long, and at least 3/4" thick. You'll also want a cookie tin or large can. The diameter of the tin will be the diameter of your banjo head. I got an 8" diameter cookie tin at the thrift store for under $1.

THE BANJO BODY

First, I used one of the leaves of the table to draw the body on. The front of the body will have a hole big enough for the ring (the tin can) to fit through. The skin goes over the hole and the ring pulls it tight. On the back a hole smaller than the ring allows pressure on the ring, but still allows sound through the back of the banjo. You want a circle bigger than the tin for the

outside diameter of the body.



I traced a bucket from the garage on the table leaf and then I laid the tin in the middle of that. Measure from the tin to the circle in a number of places until you are sure it's centered, then trace the tin can. This is for the front piece.

For the back, trace the same bucket for the outside diameter. However, for the circle in the middle, find another tin can smaller than the 8" cookie can and trace that in the middle.

Make a spacer ring to go between the front and the back. The center of this ring needs to have a hole the same size as the front so the tin can slip through it. The outside diameter of the ring can be the same as the body, but it doesn't have to be. Mine was determined by how much wood was left in the table leaf. I couldn't find a bucket or tin the right size for the outside diameter, so I made a compass.

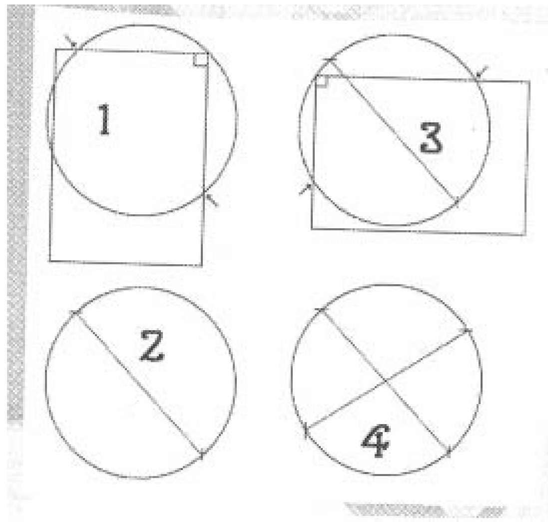
To do this, find the center of the circle, put a nail there, then wrap a piece of wire around the nail and around a pencil. Roll the wire around the pencil until it's the diameter you want for the ring. Run the pencil around the nail at the full length of the wire. I prefer wire to string because string can stretch and cause a misshapen circle.

FINDING THE CIRCLE'S CENTER

Place the right angle corner of any object (a piece of paper or cardstock works fine, as does a carpenter's square) at any point on the circle.

Mark where the two sides of the right-angle cross the circle (see arrows) and draw a line between these two marks. This is a diameter of the circle.

Place the right angle corner of the object at another point on the circle. About one-fourth way around from the first mark is a good point, but any point will work. Again mark where the two sides of the right-angle cross the circle and draw a line between them. Where those lines intersect is the center of the circle.



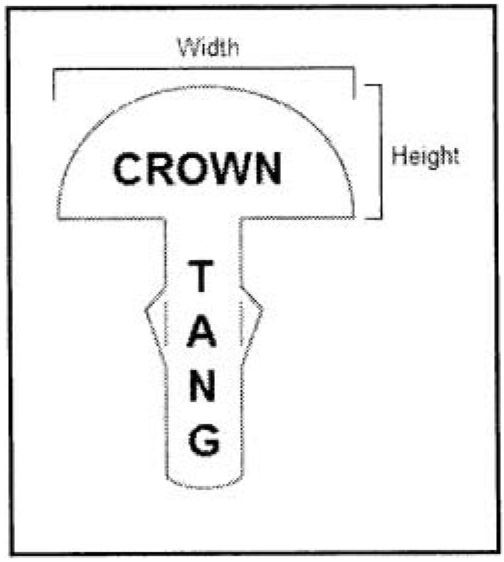
Now cut them all out using a saber saw. Start by cutting out the center sections of each circle, then go back and cut around the outside. Clamping your wood to a table or workbench is very helpful.

SHAPING THE NECK

Start to lay out the neck. On both the front and back parts of the banjo body, a little tab sticks out to attach the neck to. You want to make sure it's the right size and in the right place. I printed out a template I found on the internet and traced it onto a 3"x1"x3' piece of poplar wood. You can substitute another hardwood like oak or maple if you want.

Trace the shape of the neck onto the poplar and cut it. I used a saber saw and clamped my yardstick down as a guide. I cut until I hit a clamp, moved the clamp and then continued to the next one. The neck was also clamped to the table.

Lay that neck across the middle of both bodies drawn on the table leaf, measure to make sure it's centered and trace lines between the two bodies to make a sort of rectangle. Divided in half, that rectangle will be the tabs that hold the neck.

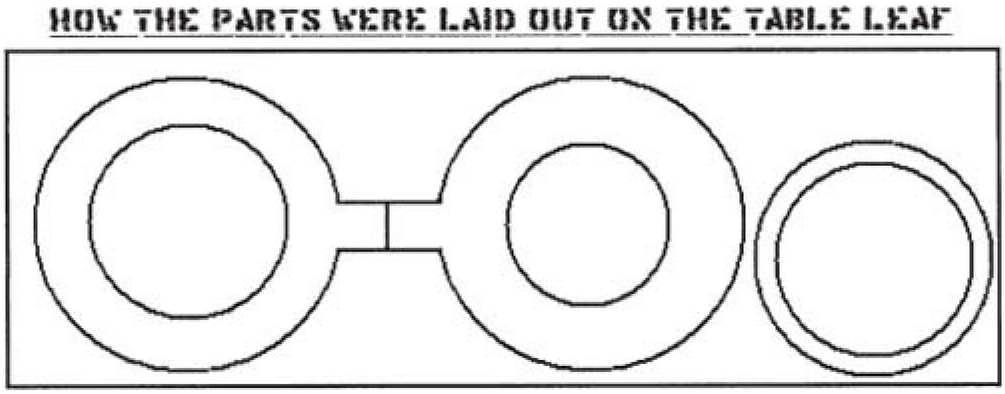


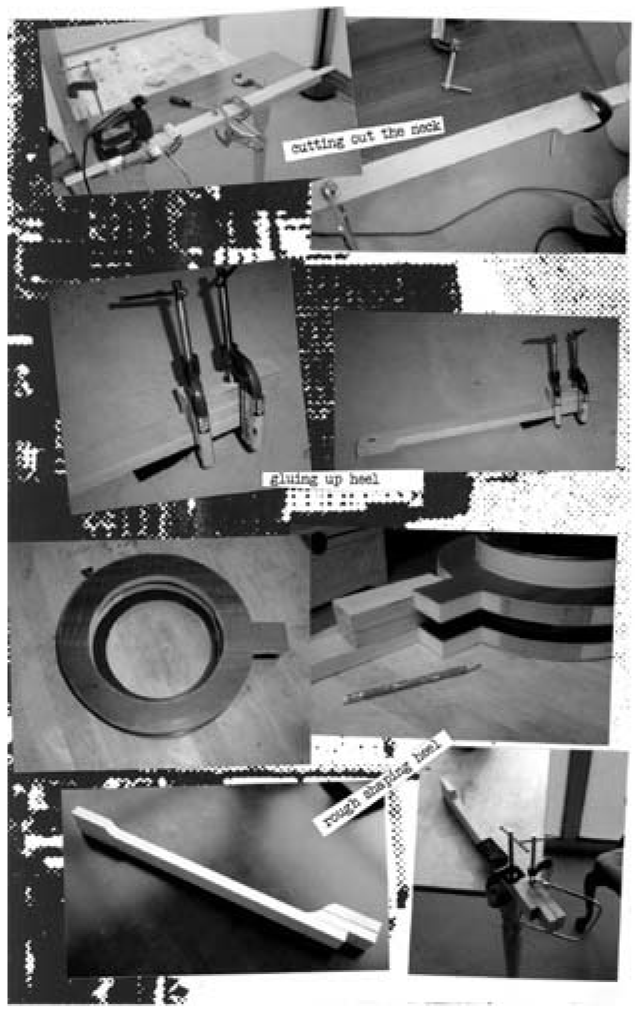
FRET WIRE

I couldn't find a local place to buy tuning pegs, fret wire, or rawskin, so I ordered them online. You can do 12 frets (a full octave) with about 2' of fret wire. Standard frets for acoustic guitars have a crown width of about .080" and a crown height of .040-.045". I got .080/.040" fret wire which is standard for modern banjos and dulcimers, but which will work fine for a cigar box guitar as well. Frets with a shorter crown height take more pressure to bring the string in good contact with the fret. Taller frets are easier to make good contact, but can be more difficult to play well.

THE SKIN

I found a place that sold rawhide for drum heads and ordered a couple extra to make more banjos or drums in the future. I ordered five instead of only one. One skin costs $11 with shipping. Five skins cost $6.50 each with shipping.





ATTACHING THE NECK

While waiting for the parts to come, I tried to determine a way to allow adjustment for the tension on the banjo head. But I realized that any adjustment would push the drum head higher through the front of the banjo, pushing the strings higher, making the banjo more difficult to play. So like

old mountain banjos, the head is non-adjustable.

The heel of the neck will be sandwiched between the tabs on the body. Cut two pieces of wood about 5” long from the same wood as the neck and glue them to the end (heel) of the neck with about 2” sticking past the end of the neck. Smear wood glue over the entire surface of the pieces and clamp them all together until dry.

If the body of the banjo is the same thickness as the neck (3/4”), you could glue a 5” piece sticking off 2”, and a 3” piece even with the end of the neck. Then that tab will slide right between the tabs on the body.

If that’s not the case, once the heel is dry, assemble the body parts face-down on a table. Set the neck face-down next to it and trace the profile of the tabs on the heel of the neck.

The heel has to be shaved so that it will slide in between those two body pieces, but have the fingerboard still above the level of the banjo body. It takes some very accurate cutting and a lot of rasping, filing, and sanding but you can get it shaped so that it will slip into the tongues and fit correctly.

Draw a curve on the side of the heel to merge it into the neck, and cut that out with a coping saw. Once the rough shape is cut out, spend some time rounding it off with a rasp, some files, and sandpaper.

One thing I’ve found that makes rasp-work go more quickly is to have your piece of wood mounted very solidly so you can use both hands and really push that rasp. I really like clamping to the arms of a chair because it’s right across my lap and no matter how much force you give, the chair doesn’t move because you’re sitting in it.

CUTTING FRET SLOTS

Now lay out and cut the fret slots. You want to do this before you start shaping the neck so you still have a factory cut to work from. The factory cut

is very straight and will give you accurate lines when you use a square. Before you cut the thin section near the head of the neck, sand down the fingerboard and get it nice and smooth. Now you can lay out and cut the fret slots. You want to do this before you start shaping the neck so you still have a factory cut to work from. The factory cut is very straight and will give you accurate lines when you use a square.

Lay your fret template on the neck, tape it down, and mark where each fret is on the factory cut side. Then use your square to mark lines across the neck with a very sharp pencil. If you want good intonation on your banjo, this is a very important part. Once you get all the lines drawn, use a pull-saw to cut the slots for the frets. Start by going forward with the saw which should barely scratch the surface. It should leave enough of a groove for the teeth to follow when you pull the saw, which is when it does the actual cutting. Cut each slot deep enough for the tang of the fret. You can gauge this by how far the saw teeth go in the wood. On my saw I cut until the teeth are halfway in the wood.

FINISHING NECK AND PEGHEAD

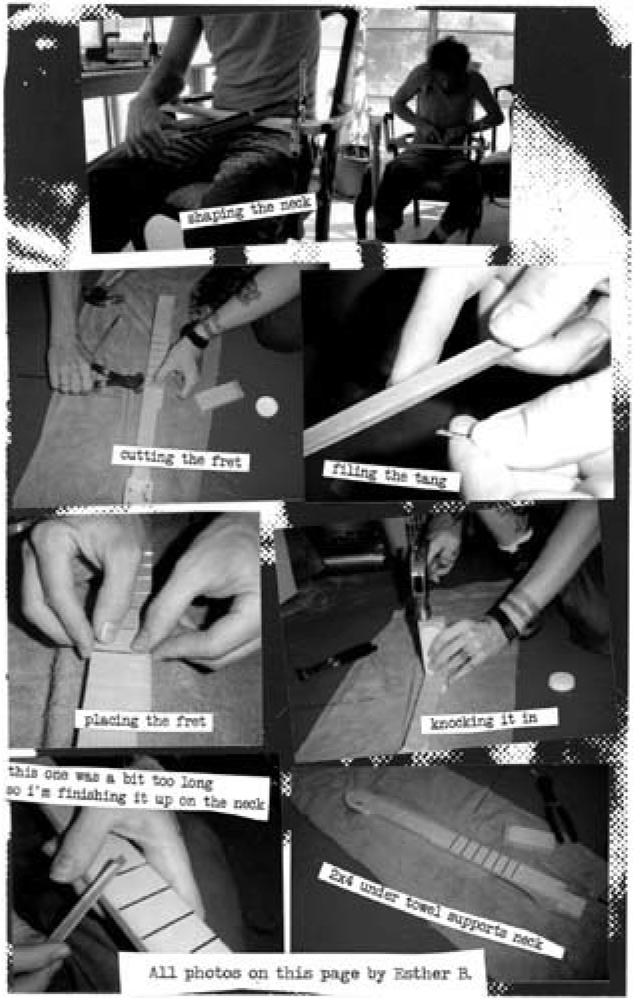
Once the fret slots are cut, go back to shaping the neck and head. Draw a design for the peghead directly on the wood. Have at least a rough idea of where you're tuners will go. I didn't do this and my tuners were a pretty tight fit. Clamp the neck to a table and use your saber saw or coping saw to cut out the shape of the peghead, and the thin part of the neck near the peghead. This might be a little tricky because of the heel, but you can clamp it down with the heel off the edge of the table.

Next, shape the back of the neck. If you can, clamp the heel to one arm of a chair and the head to the other so that the neck is across your lap. Then use a rasp to round off the back of the banjo along its entire length. When you're done with one side, flip it around and work on the other. Once you've got the rough shape done with the rasp, move to a wood file, and then a finer file, and then sandpaper.

You'll need to take some material off the front of the peghead to thin it a bit. Don't thin it all the way up to the nut, leave about half an inch. This makes it so that you can wind the string farther down the pegs. If you don't do this, your strings will be too high, and go right over the nut without even touching it.

TUNER LAYOUT

Once you get everything shaped and sanded, figure out where to put the tuners. My standard method is to hold the tuners next to the peghead and figure out where they'll fit. If you're using open geared tuners, you can take them apart and lay the mounting plates on the back of the peghead. Make sure that you leave enough room between them for the tuning knobs. Once you get your tuners laid out, drill them. For my tuners, I had to drill a ¼" hole. Usually I do this with a wood cutting bit which has a more pronounced point. I drill only until that point comes through the other side of the wood, and then I flip it over and finish from the other side. That way you don't chip the wood when the drill bit comes through. Make sure to drill the hole straight up and down and don't wobble the bit around.



FRETTING

Because this neck has a heel it won't lay flat on the floor, so put a 2x4 under the upper part of the neck. Lay a doubled-up towel over that to protect the neck from getting scratched while you're hammering the frets in.

Start on the wide part of the neck so that if you accidentally cut a fret too short, it can still be used on the narrow part of the neck. Next, lay the tang of the fret in the slot and then, using side-snip wire cutters, cut the fret to the width of the neck.

File the tang at an angle so the tang won't stick out the side of the neck. Round off the end of the crown. Once you get the ends dressed, lay the fret in the slot. Put a scrap piece of wood on top of the fret, and strike the block with

a hammer to drive the fret tang into the slot. Be careful not to hit the fretboard with the edge of that block of wood. On mine, I did 13 frets which took under 2' of fret wire.

PREPARING THE BODY

Glue the inner ring to the front of the banjo. Rough up the surfaces that will contact each other with sandpaper. Then spread yellow carpenter's glue on the inner ring, line up the two holes, and use three C-clamps to hold them together while it dries.

After that, cut your metal ring to size. Clamp all the pieces together (including the neck) and put the cookie tin in. Use a pencil to trace around the tin so you know where to cut it. You want to cut off the bottom of the tin so that you still have the finished top edge of the tin to push against the skin. Use an angle grinder with an abrasive cutting blade to cut along the line. The angle grinder cuts through tin like a hot knife through butter, so be careful as it's very easy to make a mistake.

Once cut, put it back in the body. Set two quarters on opposite ends of the neck and lay a straightedge on top of that. This way you can see about how high the strings will be over the skin. On mine, the tin stuck up a little too high, so I used the side of the cutting blade to grind off a little more. Do a quick run around the entire circumference of the tin and then try it again. I did this a couple times until the top of the tin was even with the top of the banjo body. While the pieces are clamped together, drill four holes through the back of the banjo and into the inner-ring. You can use these to screw the back of the banjo to the front.

STRETCHING THE SKIN

My 12" diameter calf skin was barely big enough. Goat skins are the preferred skin for making banjos because goat skin is thinner, but the 10" skins I'd ordered weren't big enough.

Fill a pot with hot water and submerge the skin, using a couple rocks to hold

it underwater. While this is soaking, grab a piece of scrap wood and drill two holes that match the ones already drilled in the banjo body. You'll use this to hold in the metal ring while you stretch the skin. In about 10 minutes the skin will be soft enough to work with.

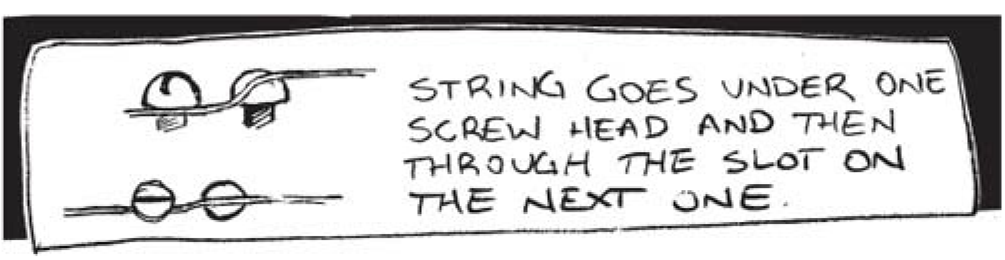
Lay the front of the body facedown with the inner ring exposed. Lay the calf skin over the hole and use the metal ring to push the skin into the body of the banjo. You might have to do this a couple times to get the skin centered, so you have enough sticking out all the way around to fold over and staple. Make sure that the rounded edge (not the cut edge) of the tin is in contact with the skin.

Once centered correctly, push the ring all the way into the banjo body. Then screw that piece of lathe across it to hold it down while you "stretch" the skin. The skin will shrink as it dries.

Pull the skin over the inner ring and staple it down. Start with an "X" pattern and then put another staple between each of those and then staples between each of those. Keep doing that until the staples are about ½" 3/4" to apart.

Once it's all stapled, remove the piece of scrap wood that holds the metal ring. Put the back of the banjo on and drive screws into the four holes you've drilled. Then set it aside to dry. Once you get the skin stretched, you don't want to touch it again until it dries.

Let it dry overnight to be safe. In the morning it should be nice and tight, sounding like a drum when tapped.



TUNER/ZITHER PIN INSTALLATION

You're now going to put the tuners in the holes and screw them on. Those first four are no big deal. The fifth peg that goes partway down the neck is a little tricky. I didn't buy a special banjo fifth string peg, so I decided to go with a zither pin. They only cost about 30 cents each, but you have to use something like a clock key to turn them.

For a standard zither pin, drill a 3/16" hole. Drill it deep enough to cover all the "threads". Keep your drill very straight as any wobbling of the drill bit will make the hole bigger and the pin won't fit as tight as it should.

Once the hole is drilled, use your tuning key to twist the pin into the hole. Start it with a hammer if you want, but I prefer to screw them in. A zither pin

works kind of like a finely-threaded screw: as you turn it clockwise it screws in, and as you turn it counter-clockwise it screws out.

Like a screw, you don't want to keep turning it once it's all the way in, or else you'll strip the hole. For most instruments this means that you'll want to back the pin out a ways before you put on the string and start tuning. On the banjo it works opposite, but I'll explain that when we get there.

Put your zither pin (or 5th string banjo tuner) between the third and fourth frets, but closer to the fourth. Don't pay attention to where I put mine. It should go on the thin part of the neck. I didn't look at a banjo before I did mine and got it in the wrong place. It will work better if it's on the thin part of the neck.

If you want to use a straight fifth string banjo tuner, it's easy and you won't have to carry a tuning key. A geared tuner requires special tools, so avoid those. Drill a hole the correct size for your tuner. Remove the tuning knob and, using a piece of wood with a hole drilled in it, hammer the tuner into the hole. Then replace the tuning knob.

ATTACHING THE NECK

Set the banjo facedown and remove the back of the banjo. Set the neck where it goes and drill three holes through the tab of the neck and into the front tab. Drive in three drywall screws until the heads are even with the surface of the neck. Replace the back of the banjo.

BRIDGE AND NUT

Cut a bridge using a leftover scrap of wood from the neck. The pull-saw works really nice for this detail work but it can also be done with a hacksaw. Mine was about as wide as the widest part of the neck, a little over 1/8" thick and about 3/8" tall.

1/8" looks pretty thick, but I wanted it to have a pretty big footprint so it would spread the string tension over a wider area of the skin. You can angle

the edges a bit, for looks. Mark where the strings will be; 1 cm apart is pretty common. Start at the center and work out until you've marked all five strings. Using a three-sided file, put enough of a notch to keep the string from moving.

Cut another piece 1/8" thick, but only about half as tall and only as wide as the thin part of the neck. This one is for the nut.

Mark this one for four strings. The outside strings should be 1/8" from the edge of the neck. Space the other two evenly between that. Use the file to notch where the strings will go. When I cut the slots for the frets, I accidentally cut a slot where the nut goes, too, so I decided to use that mistake for my benefit. I laid the edge of the nut on the first slot and then marked the other side. Then I cut another slot the same depth and then used a small chisel to pry the little pieces out.

Now I had a slot the same thickness as the nut. I cleaned up the bottom of the slot with the chisel and then put the nut into the slot. This way the nut is held in place without any glue.

TAILPIECE

About the only thing left is to make some kind of tailpiece. You could put five screws in the face of the banjo, but I wanted something unique. Clamp the tines of a fork in a vise or between blocks of wood and bend them over about 90 degrees. Use needle-nose pliers to bend them into hook shapes.

Use a hacksaw to cut the handle off and round off the edge with a file. Use pliers to bend that rounded edge over. Try it on the edge of the banjo and figure out where the hole needs to be drilled. To make sure it ended up in the right place, lay a straightedge down the neck and mark where the center of the neck met the end of the banjo. Then, drill a hole and screw on the tailpiece.

STRINGS

Since the neck doesn’t have a truss rod (a metal rod that gives the neck more strength against the tension of the strings), you’ll want to use light-gauge banjo strings. This will prevent the neck from bending under the tension of heavier gauge strings. Slip the loop over one of the fork tines, and the other end in the tuning peg. Put on the four full-length strings first. They have to be wrapped down the peg in order for them to be low enough to rest on the nut. If you can’t get the strings low enough to rest on the nut, you can buy string trees to hold them down. Or you can drive in screws where the head of the screw can hold the string down.

If you’re using a zither pin for your fifth string tuner, you may want to tune “backwards”. Normally, you tune them by turning them clockwise, but this will have the string passing under the zither pin. If you want the string to pass over the zither pin, turn the pin all the way into the neck, and then you can tune by turning it counterclockwise.

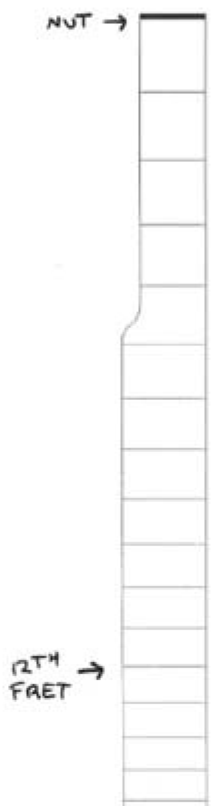
FIFTH STRING NUT

Because it’s short, the fifth string will need its own nut. Cheap banjos sometimes use a small slotted screw, and that’s what we’re going to use. I like to do this when the strings are already on so I know exactly where the nut should be. It should be directly behind the fifth fret (between the fourth and fifth frets), and evenly spaced from the next string (about 1/8” from the edge of the neck). Using a tiny drill bit, make a pilot hole for a very tiny slotted screw. Screw this in so that the slot is perpendicular to the fret. When the string is in the slot it should barely clear the fifth fret.

TUNING THE BANJO

The banjo is tuned to an open-G chord. Starting at the short top string, the strings are tuned G-D-G-B-D. If you don’t have a tuner, you can tune the

banjo to itself. Start by bringing the fourth string to a reasonable tension, not too tight and not too sloppy. Then, finger the fourth string at the fifth fret. Play the fingered fourth string and the third string and tune the third string until it sounds exactly the same as the fourth string fingered at the fifth fret.



Now the 3rd string is in tune with the fourth. The rest of the strings work similarly. Finger the fourth fret of the third string to tune string two. Finger the third fret of the second string to tune the first string. Finger the first string at the fifth fret to tune the 5th string. Now the banjo is in tune with itself.

I am very impressed with the sound of this banjo; it doesn't look like a million bucks, but it sure sounds nice. It has all the volume that a banjo should have and it sounds really crisp.

I'm not sure how long it took me to build this. Rachael says, "about a million hours" but it really wasn't that bad.

SUPPLY LIST

- wood from the table - $3 with enough leftover to build four more banjos
- 1”x3” poplar for neck = $3
- 12” thick calfskin = $6.60
- tuners = $2.30
- fret wire = $3.25
- strings = $5

So, it ended up costing about $20 to build the banjo, which is pretty good considering it would run about $150 to $200 to buy one.

BIKE SPOKE KALIMBA (THUMB PIANO)

I thought it would be easier to make a kalimba with flat tines, but couldn’t find any. I looked for old rakes or similar thin flat metal strips. Not finding any, I gave it a shot with round tines. I figured it’d be best to pound the ends flat so they’d be easier on the fingers. Bike spokes ended up being a perfect solution—they already have little pads on the end!

I cut nine spokes with each slightly shorter than the previous one. I grabbed a

lid from a little wooden box to use as the base, and cut a piece of hardwood dowel a little shorter than the lid was wide.

I marked the middle and made 4 marks on each side, about a centimeter apart. These marks are where the tines sit. Cut an identical piece of dowel, lay it next to the first, and transfer the marks. This piece holds the tines down. In order to get the round tines to stay where they're supposed to, use a hacksaw to cut little groves on each of the marks.

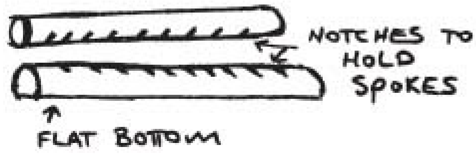
On one of the pieces, file a flat spot on the side opposite the grooves, so it will sit flat on the box. In the other one, drill three holes. The tricky part is getting everything to stay put while you get it all together. Lay one dowel on the box lid and lay spokes on each of the grooves.

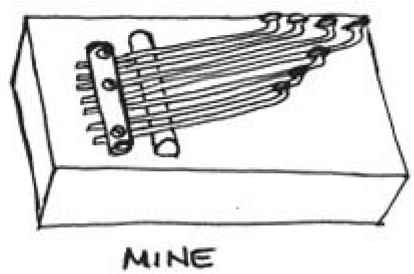
Use the dowel with drilled holes to push down the spokes behind the first dowel. Once everything is in place, screw the dowel to the box lid.

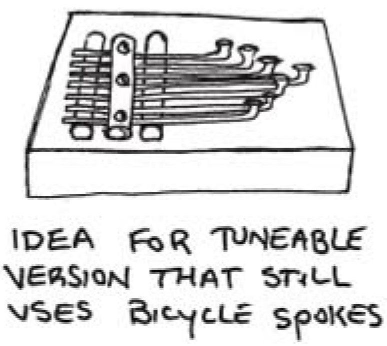
The way I set mine up, it's a bit tricky to tune because you can't really slide the tines in and out. Whatever size you cut them to then determines what note they make. If you put down two dowels (screwing one between them), this would allow you to slide the tines in or out to tune them.

My kalimba doesn't have a bottom, so I didn't bother drilling a sound hole. If your box has a bottom, a sound hole in the top of the box will really improve the volume. I was originally going to put a bottom on mine, but I've found that with the bottom open I can set the kalimba on different things to get a different sound.

One of my favorites is a coffee can. It's the right size so that the kalimba will sit on top of it, but is large enough that the sound can escape around the body of kalimba. This gives me ideas for future builds!







RAKE TINE KALIMBA

I finally found a couple old rakes someone threw away so I set out to build my flat tine kalimba!

Start with a small wooden box. You could build your own if you can't seem to find one. You could also use a piece of wood and skip the box. You can see them built that way at a music shop.

Cut a piece of ½" square dowel to be a little shorter than the width of the box.

Cut a piece of lathe about the same size. A piece of ½x2” hardwood looks better, if you have any on hand.

Cut a piece of bike spoke the same length as both of those. Set these on the box, and figure out where the tines go so you can drill a sound hole under them. Mark the center of the box, and drill a 2” hole using a hole saw.

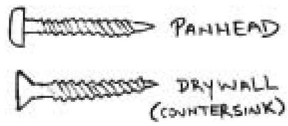
Drill some pilot holes through the ½” dowel and lathe, one on each end and one near the middle. Cut another piece of lathe that will fit inside the box and glue it under where the pieces will go on top.

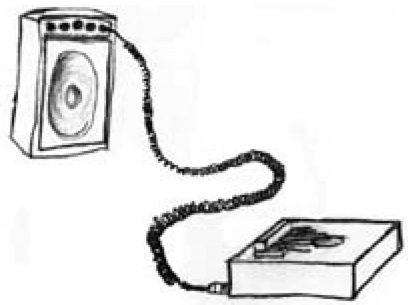
Drive some 1” pan head screws through the pilot holes, the box top, and into the lathe. The lathe inside helps anchor the screws, especially if your box top is very thin. Don’t drive them in all the way, leaving a bit of room between the square dowel and lathe.

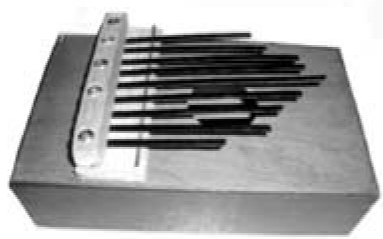
Remove the rake tines (from the rake), cut the curved end off, and grind off any sharp edges. Slip nine of them between the square dowel and lathe. Put the length of bike spoke on top of the lathe and under the tines.

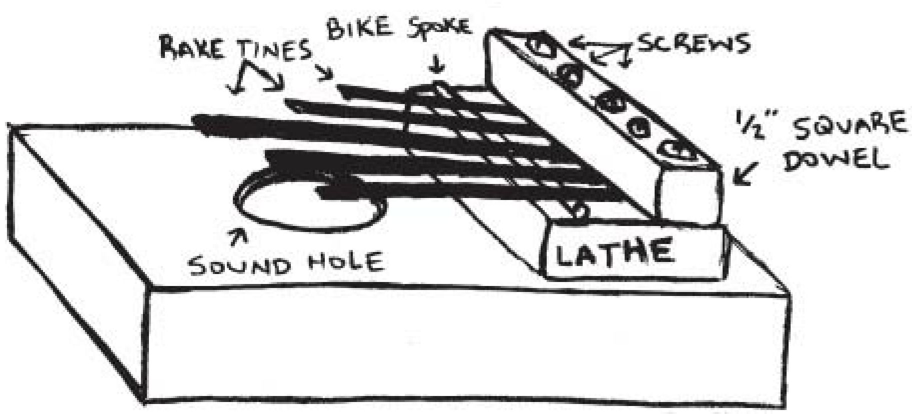
Push them through, so the kalimba tine in the middle sticks out the farthest and the rest get progressively shorter as they near the box’s edge. When you have them where you want them, tighten the screws the rest of the way. If the tines don’t all hold tight, drill two more holes between tines and put in a couple more screws.

Once you get the screws tightened and the tines staying put, use an angle grinder to cut the excess off. If you don’t have an angle grinder, cut your tines to approximate length before building your kalimba. Mine range from 3-5.25” long, and I’m pretty happy with that. Tune the kalimba by moving the tines in or out to change the pitch.

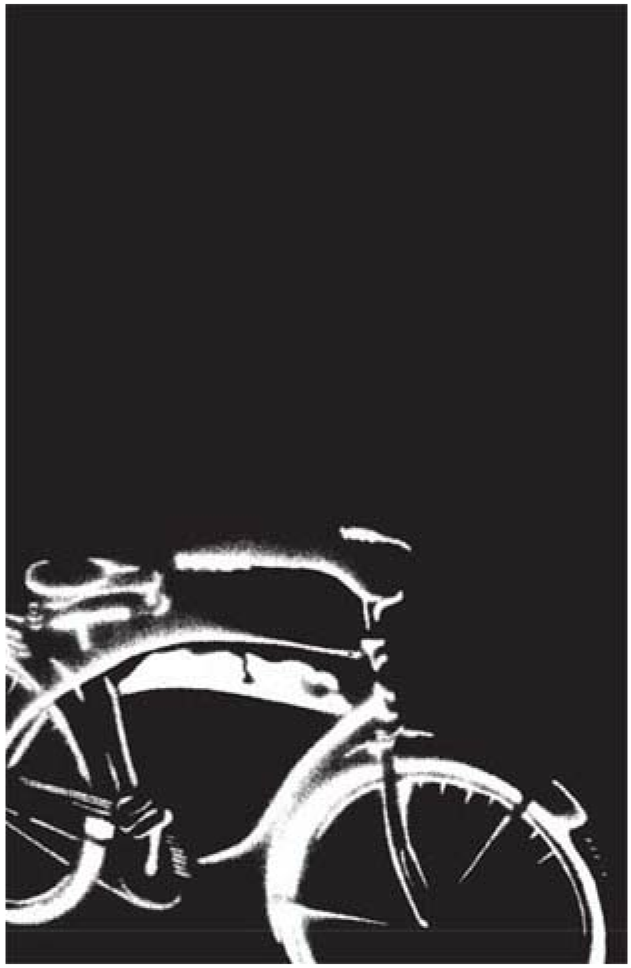

PANHEAD
DRYWALL
(COUNTERSINK)






RAKE TINES
BIKE SPOKE
SCREWS
1/2" SQUARE
DOWEL
LATHE
SOUND HOLE

EVERYTHING ELSE



BUILDING A CART THAT CONVERTS INTO A TABLE

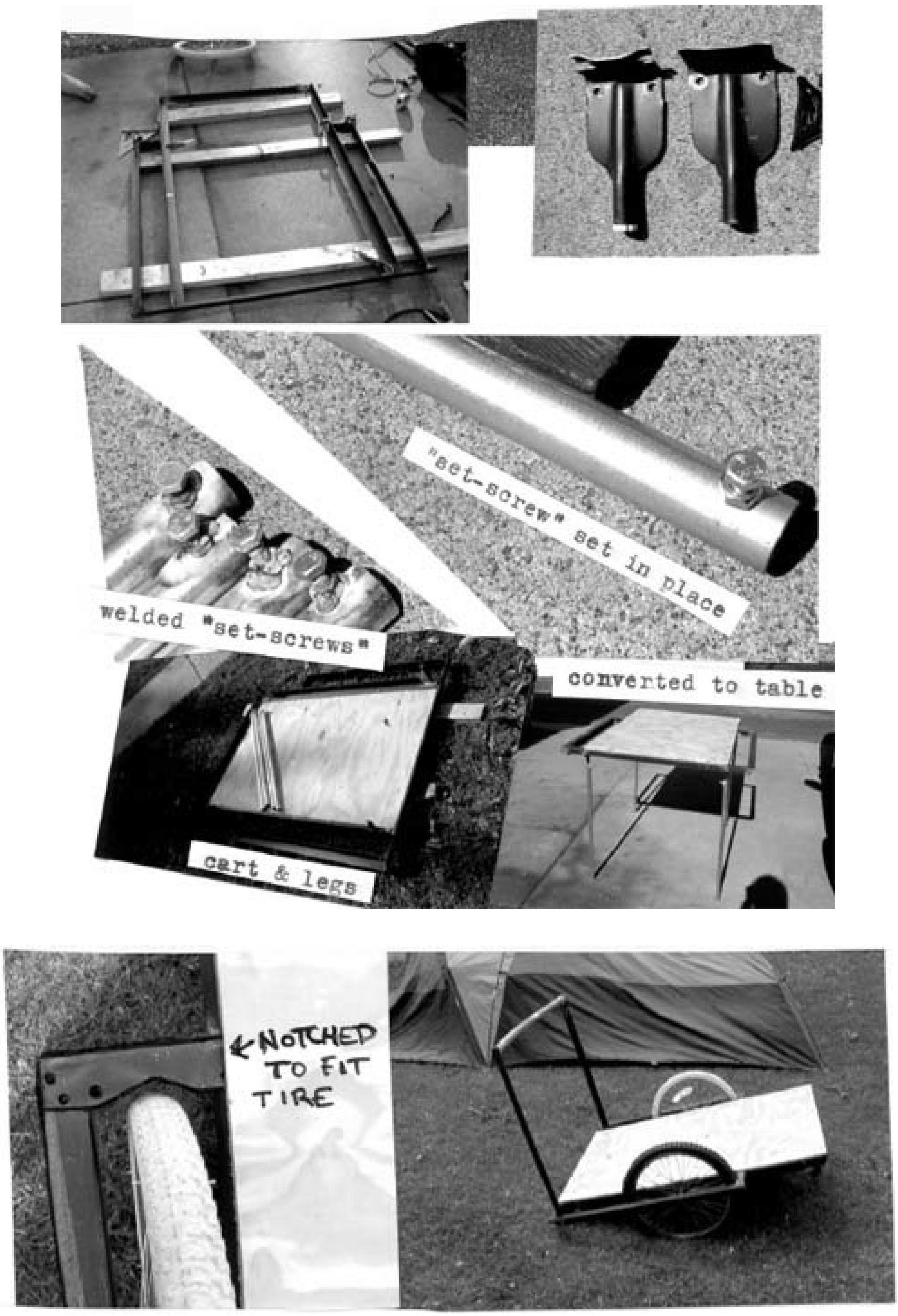
Rachael and I decided to go to the PAPA (People Against Poverty and Apathy) Festival this year. We had to bring all our own food and drinking water as well as camping gear for the family. The half-mile hike from the van to the campground with all that stuff didn't sound like a lot of fun, so I decided to make a cart.

"Will it fold into a table?" Rachael asked. So that got added to the plan.

I went with a design similar to the bed frame bike trailer and decided to make it 4' long and 3.5' wide—big enough to fit in the back of the van. The width of the wheel slots are 5" each, so I had to subtract 10" to come up with 2.7' as the width of the platform.

I got to work measuring the bed frames I had on hand. If you look at the picture of the frames, you'll notice that the wheel slots don't run the whole length of the trailer like the last one. They don't need to because the trailer is longer than the diameter of the wheels. This way I was able to use the pieces I had on hand without a lot of waste.

I marked the pieces and made drop outs for the wheels like I did on the trailer. This time I didn't use a jig—I laid it out on 2x4s, checked it with a framer's square, and then clamped it all together while I welded it.



I had some ideas for folding legs. Then I noticed that the legs I'd cut off one of the bed frames were rounded. A piece of 3/4" conduit fit perfectly over the end. So I welded one of the bed frame legs in each corner of the trailer. Then I cut the legs out of a 10' length of conduit into four equal lengths. Actually, my

kids did it for me and learned to use a pipe cutter in the process.

I made set screws to hold the conduit to the bed frame legs. To do this, drill a ¼” hole through the tube. Put a nut over the hole and put a screw into it to keep the nut positioned correctly over the hole while welding.

Weld the nut to the conduit. Loosen the screw immediately so it doesn’t get stuck in the nut. I tested the fit on the legs and they all worked perfectly. So I screwed a piece of plywood to the frame.

If you don’t have welding equipment, put the table legs over the bed legs and then drill a hole all the way through both of them. Hold them together with a nut and bolt or a cotter pin.

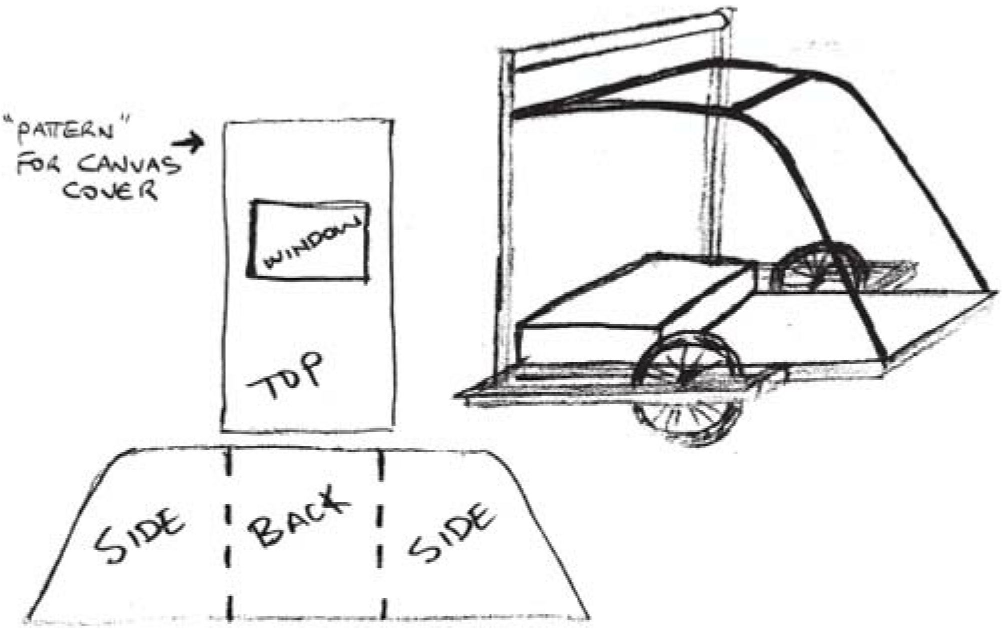
The last thing to do was to create a cart handle. I decided on something like a shopping cart. I grabbed two equal lengths of bed frame and clamped them sticking up near the back of the cart. A piece of 1.5” conduit clamped between them made a nice handle. I drilled two holes where the bottom of the handle pieces met the cart, and screwed them to the cart. Then I welded the conduit between them. If you don’t weld, this could be bolted. A couple bungee cords made from bike tubes worked to attach the table legs to the handle. I have an idea for converting this cart into a trailer for carrying kids, but since I don’t need one, I haven’t followed through on it.

First you would add a towing arm, to convert it into a trailer. Then make a little box for the kids to sit on, which could also store wrenches and spare tubes.

CONVERTING IT INTO A KIDS' TRAILER (IN THEORY)

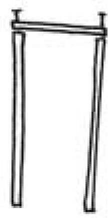
It should be easy to make a canvas cover that will attach to a minimal frame. One more crossbar would go under the handle so that the handle could still be used with the cover in use. Then I'd run curved pieces from the crossbar to the front of the trailer.

One length of canvas could make the back and sides—this would attach with snaps screwed to the plywood and frame. The top would be from another piece of canvas, with a screen sewn in and a clear plastic flap that would stay rolled up when it isn't needed. This would attach to the frame with Velcro, so it can be easily removed on hot days.

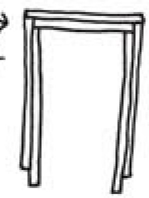

"PATTERN"
FOR CANVAS
COVER
WINDOW
TOP
SIDE
BACK
SIDE

FOLDING "CAMP" CHAIR

START WITH AN 8 FOOT LENGTH OF FIRING STRIP. THIS IS ABOUT THE SAME AS A 1"x2" BOARD, BUT LOWER QUALITY SO IT ONLY COSTS 65¢ EACH. CUT THAT INTO 4 EQUAL LENGTHS (24" EACH). THESE WILL BE THE LEGS. NEXT CUT A LENGTH OF BOARD AS WIDE AS YOU WANT THE SEAT. (I DID 16 INCHES). NAIL THAT TO THE TOP OF THE LEGS WITH RING SHANK NAILS, OR PREDRILL AND USE SCREWS. I ACTUALLY DID BOTH.

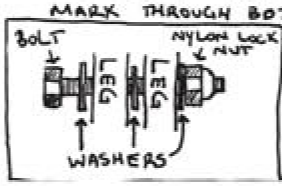


NOW MEASURE THE DISTANCE BETWEEN THE LEGS AND CUT A BOARD THAT LENGTH. NAIL OR SCREW THAT TO THE TOP OF THE OTHER LEGS. PUT THAT INSIDE THE OTHER PART. IT WILL LOOK LIKE THIS



THE INSIDE LEGS WILL BE A BIT LONGER. JUST MARK THEM AND TRIM THEM OFF. NOW MARK 12 INCHES FROM THE TOP IN THE CENTER OF THE BOARD.

CLAMP THE INNER LEG TO THE OUTTER LEG. THE INNER LEGS SHOULD BE SLID DOWN ABOUT 1/8". DRILL A HOLE ON YOUR MARK THROUGH BOTH LEGS.

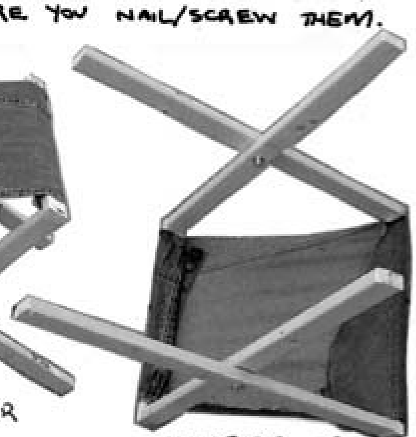


PUT A BOLT THROUGH WITH WASHERS ON EACH END & IN THE MIDDLE. A NYLON LOCK NUT WILL PREVENT IT FROM COMING LOOSE WITH USE.

ALL THAT'S LEFT NOW IS TO ADD THE FABRIC. I USED THE SLEEVE FROM A JEAN JACKET. IT'S PROBABLY NOT THE BEST CHOICE. DENIM TENDS TO STAY WET FOR A LONG TIME (IF IT GETS WET, WHICH IS BOUND TO HAPPEN AT SOME POINT WHEN YOU'RE CAMPING) BUT I HAD IT AROUND. IT WAS ALSO A BIT TRICKY BECAUSE IT WAS ODDLY SHAPED.

WHATEVER FABRIC YOU CHOOSE, JUST CUT IT TO THE WIDTH OF THE NARROW SIDE. IT SHOULD BE A BIT LONGER THAN IT IS WIDE. THEN JUST WRAP IT AROUND THE TOP PIECES AND STAPLE IT TO THE UNDERSIDE. ALTERNATIVELY, YOU COULD SEW A SLEEVE ON EACH SIDE. IF YOU DO THAT YOU'LL WANT TO SLIDE THEM ON THE TOP PIECES BEFORE YOU NAIL/SCREW THEM.

"CAMP" CHAIR



UNDERSIDE OF "CAMP" CHAIR

FABRIC BOOK COVERS

I do a lot of writing, so I use a lot of blank books. I like something a little more permanent than notebooks but small enough to fit in a small bag. I find that half-letter or half-legal sized blank books are about perfect.

At work we have a binding machine, so I started making blank books from scrap paper. You can find self-service binding machines in the copy section of office supply and copy shops.

One way to make the books last longer is to put fabric covers on them. It gives it a nice look and protects plastic binding from getting broken. I also do this to protect books that I carry around often.

Lay the book open on a piece of fabric. Cut the fabric so it's about an inch larger than the open book all the way around. Old pants work well and you can have a pocket on your book cover!

Upholstery fabric works well too. I really like the old, flowery couch fabric from the '70s. You want something thick.

Smear a layer of white glue on one cover and press the fabric on. Close the book and glue the other cover, pulling the fabric tight when you do. Don't glue the other cover while the book is open or else the book will not close.

Cut the corners off the fabric at a 45 degree angle at the corner of the book. Do the same with the inside corners of the cover, so there is no fabric directly above the binding.

Now you have six flaps of fabric. Fold them over one at a time and glue them to the inside of the cover. Make sure that the fabric doesn't overlap anywhere —overlaps don't stay glued well.

You can leave the cover like this if you want, but I think it looks better if you

glue a page to the inside of the cover so the fabric doesn't show. It also lasts longer.

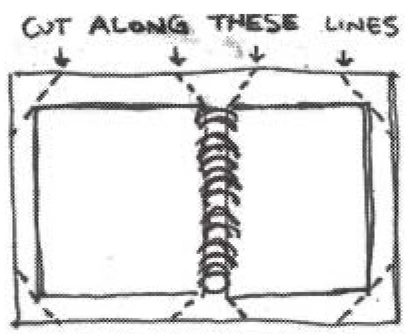
Open the book with the pages to one side and put a large piece of paper under the first page, so that it sticks out on all sides. This keeps glue from getting on the pages behind it. Smear white glue all over that page, making sure to get all the way to the edges, but stopping about ¼" from the binding.

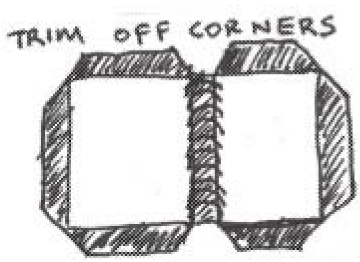
Close the book, pressing that first page to the inside of the cover. Do the back cover the same way. Set a heavy book on top while it dries.

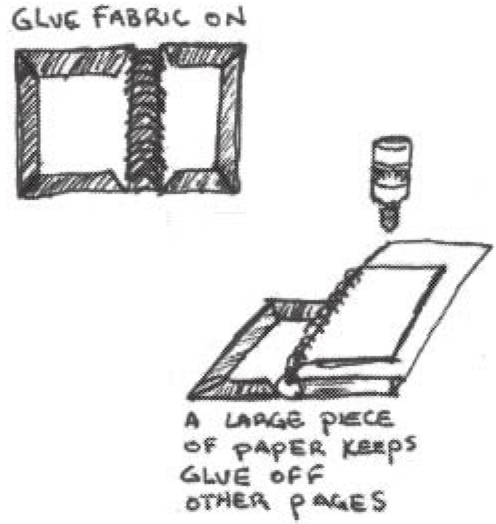
The picture shows two books that I put fabric covers on.

One is faux-fur from the thrift store. The other is denim from a pair of my daughter's old jeans.

That book has a pocket on the front and the back. I like to use memorable materials, like my daughter's very small pants, or a pair of pants showcasing a patch made by a friend or a shirt bought on a road trip with good friends.







"RUBBER" STAMPS

Here are a couple of the blank books I've made. The one on the left shows what my books look like before being covered. That one was decorated with "rubber" stamps made from erasers.

They are super easy to make. You need a large square eraser that you can pick up during "back to school" sales for a quarter. Draw your design on the eraser and trace the entire design with a hobby knife.

Then go back and remove the material around the design. Carve it out from the sides or scrape it out.

It takes about 10 minutes to make. You can use an ink pad, but I use acrylic paint because it works better on some things and usually gives a more even image.

Smear a thin layer of paint on a piece of cardboard, dip the stamp in it, and apply to whatever!

SIMPLE WATCH REPAIRS

Unlike everyone else I know, I'm not big on keeping track of time. Every Christmas, Rachel buys me a new watch—because I'm really tough on them and tend to break them before the year is up. Since watches aren't made to last, here's a couple things we've done to keep our watches going for a bit longer.

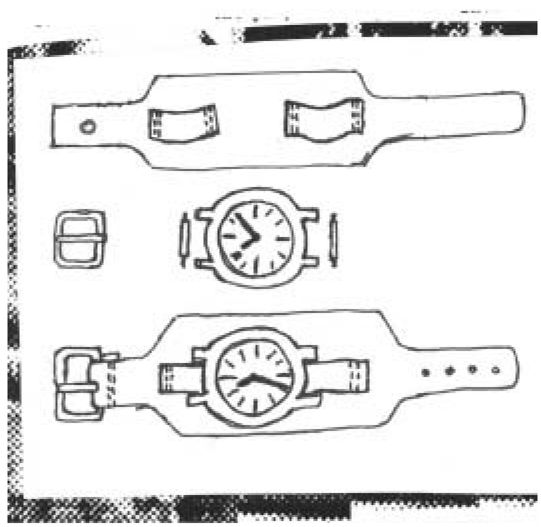
Rachael's watch band broke, so I found some leather from an old leather jacket. Usually, watch bands are in two pieces and there are two pins that go through loops (or tunnels) at the end of each band. Rachael went with a "one piece" band—rather than having loops at the end, they were in the middle.

We considered cutting slits for the pins to go through, but she decided to sew on little tabs instead. The tabs are thin enough to fit between the protrusions on the watch where the pins go, and they're sewn to the watch band on both ends. Sew everything with thick upholstery thread.

Then, slide the watch pins under the tabs, set the watch on top, and get the

pins into the protrusions. The buckle was easy to attach. Fold one end of the strap over, cut a hole for the pin, slide the buckle into place, and sew it.

A few days ago I knocked the face of my watch on something and chipped it. It wasn't too bad on the outside, but inside some chips of glass came loose inside and got under the hands so that the watch wouldn't keep time. In order for it to keep time again, I had to remove the face and get those chips out. There was a little hole right at the edge of the glass, so I put in a tiny screwdriver and pried it up.



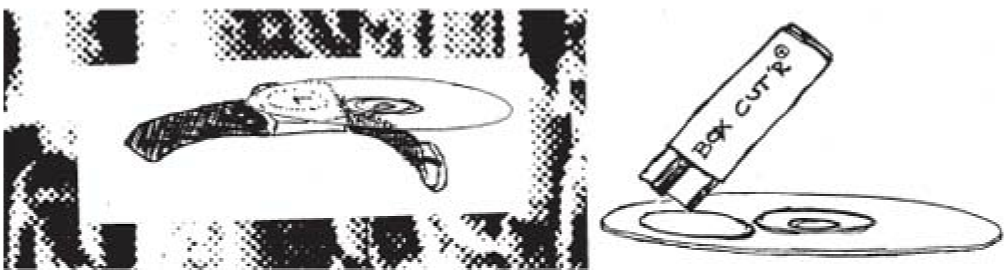
Then I had to find something to replace the face. I tried to think of something that was flat clear plastic. Looking around my desk I saw a CD and remembered the clear disk that comes in every spindle of CD-R's. I think that a CD or cassette case would work, too.

I laid it on top of my watch and, using a marker, I carefully traced the shape of the opening onto the plastic. When on the watch, you can see through the disk and easily see the opening where the face fits.

Using a box cutter cut out the circle. Start by cutting a groove all the way around the circle, then keep going over the groove using more pressure until it cuts all the way through. If the piece is too large, go all the way around again trimming off a hair.

As it gets very close to fitting, lay it on the watch and mark the exact spots that need to be trimmed.

Once it fits nice and tight, glue it in with some epoxy. More glue makes it water tight but less glue looks better.



STIENCILS

Letters are a good place to start, but anybody who's seen a Crass album can

probably figure out how to do letters. So I'm going to pass on some tips for doing more advanced stencils.

Pick out some artwork with fairly high contrast. If you want to do a stencil of a bicycle, it's helpful to have the bicycle with a light background. If the bike is in front of a bunch of trees, that makes things harder when you cut the stencil.

Take the picture that you're using and seriously increase the contrast. Computers have made this really easy, but you can do it on a photocopier too. Increase the contrast while lightening the picture until you have a black and white image.

Figure out if you're going to use spraypaint or acrylic paint. With acrylic, you should use transparency film; for spraypaint, use cardstock. Both of these can be run through the copier, which saves you the trouble of drawing your design.

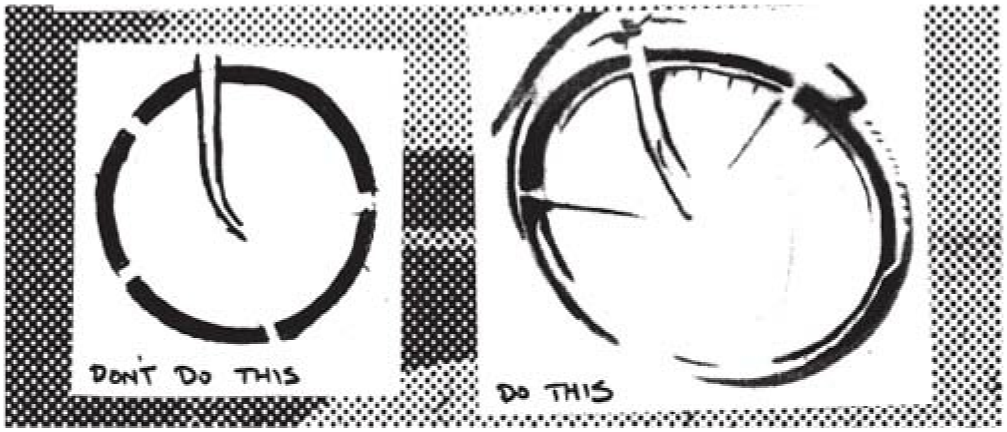
One thing that works great are priority mail and FedEx envelopes. Cut them to size and send through the copier. Heavier cardstock seems to jam and often times the image won't set correctly and will rub off before you get your design cut.

You have to teach yourself to see the picture as small areas of black. Don't look at the tire as one big black ring, because you can't cut a big ring, or you'll end up with a big black hole. The object is to give the illusion of a big black ring without actually having a big black ring.

Work within the contours of the picture. If you have a black ring, don't run a white line straight through the middle to connect the inside to the outside. Try to find a way to make it look like it's supposed to be there.

Look at the front wheel of the bike stencil. The tire has been split into 4 major

parts. The fender supports are a perfect place to cut the ring into sections, and at the bottom the lines sort of peter out before they touch each other.



You could overlap them like I did with the inside and outside sections of the front. The white line between the two at about the 5 o'clock position on the tire isn't noticeable unless you look for it.

One of my favorite methods is to let the line thin out before it actually reaches the point where it would connect. Often times this gives the look of shading and the illusion of continuity.

Instead of trying to plan things out beforehand, look at the picture one piece at a time. Cut out the section of tire between the fork and the fender support. Cut the other one. Work on the pieces directly under that. Start to see the picture as small chunks of black.

You won't get an exact duplicate of the modified picture, and generally you don't really want to. For example, in a high contrast picture it's difficult to tell that there's a fender on the front tire. But by adding a little bit of shading in the front, and leaving it off the back, it's evident in the stencil that the front tire has a fender over it. Don't trace the picture. Make improvements as you

go.

Here's an example I deemed too complicated to do as a single stencil, so I split it into two parts. The butterfly on the next page is one part and the skull and crossbones is a separate stencil.

Look at the original picture of the butterfly. There's an awful lot of black and dark grey with white sections in the middle. These won't work on a stencil so I came up with a way to work with the shapes that were present in the wing. Look at the bottom edge of the wing where I've extended the curve of the white shapes to touch the edge of the wing dividing the edge into small sections of black. A straight white line wouldn't look right, but working with the curves makes it seem natural.

This alters the image quite a bit. I don't know if anybody would recognize it as a swallowtail butterfly anymore, but it's clearly a butterfly.

At the top of the wing you can see where I've used the method of thinning out the lines before they actually touch.

Start off with the fine details first and wrap up with the large areas. The more cardstock you remove, the more it will want to bend and rip. If you cut the small sections before the big ones, this is less likely to happen.

You'll want a super sharp knife too. Box cutters and utility knives will work in a pinch, but your best bet is a hobby knife (commonly referred to as an Exacto knife.) If you rip the cardstock or make an errant cut, you can repair it by putting pieces of tape on both the front and back of that section. Then cut that section again.

With a two-piece stencil, you'll need to make sure that the pieces fit together correctly. For this one, I cut both the stencils separately. Then I cut a piece of cardstock the shape of the skull and crossbones but slightly larger. I taped this

over the butterfly stencil. Once the butterfly was spraypainted, there was a blank spot for the skull. This method worked out well, because we were able to adjust where the skull was placed on the butterfly.

Now you're ready to paint. If you're doing shirts, you'll want to start out by slipping a piece of cardboard into the shirt. It should be as wide as the shirt or slightly wider so that it holds the fabric tight so you're not stenciling over wrinkles. If your cardboard is centered and straight, it also makes it easy to get the stencil in the correct position. Most importantly, if you don't use cardboard there is a good chance your design will bleed through to the back of the shirt.

Make a border for your stencil to prevent overspray from discoloring the shirt outside the border of the stencil. This can be as simple as pieces of newspaper laid around the outside, or you can make something more permanent. I like to cut open a brown bag, cut a hole for the stencil and tape the border on. You can see this in the picture of the bike stencil.

In that same picture, you can also see white rings on the stencil. That is where I set metal washers to hold the stencil flat while I'm painting. You can hold the stencil with your fingers, but I find that a few small weights make for a crisper image. I like washers because the paint "glues" them to the stencil (making them semi-permanent) but you can use wrenches, scrap metal or whatever's handy.

When you paint, do a number of light coats. Go back and forth over the stencil until it's dark enough. Don't spray in one spot until it's dark. If you try to get too much paint in one spot all at once it can soak into the fabric and bleed. If you're doing something other than fabric, it can run. You don't have to let it dry between coats, so go over it lightly until it's as dark as you want it.

If you're doing a lot of shirts at once, use a rag to dab the excess paint off the stencil every few shirts. Otherwise it will puddle up and run into the fabric.

This also keeps the small spaces from clogging with paint. If it does become clogged, let it dry and recut the clogged areas with your hobby knife.

Another way to do stencils is on transparency film, or a similar thing plastic. I did the skull and butterfly design again, but this time much smaller and therefore much simpler. We used these for stenciling Rachael's CD covers.

The main difference with transparency stencils is the method of applying the paint. I don't recommend using spray paint because it can deform the plastic. These stencils work best with acrylic paint. These stencils give you a much cleaner design, and the acrylic paint tends to last longer on fabric.

You can apply the paint using a standard kitchen sponge or a special painting tool which has a handle attached to a small sponge. This was my first time using them, and they sure do work nice!

Dab your sponge in the paint and then dab it on the stencil, making sure to press hard enough to get the paint through all the holes. Depending on the size of your stencil, you may have to dip into the paint a few times. As you do this, make sure to hold the stencil in the exact same place. Once the entire area is coated, remove the stencil.

While doing the CD covers, we found that we could do about 10 covers before the small parts of the stencil started to clog up. On less detailed stencils you can get a lot more prints before it clogs up. When this happens, carefully

wash the stencil with warm water and dry it. When you're done stenciling wash it one more time and then hang it up to dry. If paint starts to build up in the stencil, you can use a hobby knife to carefully scrape it out.

If you want to be able to use your stencils over and over, store them flat. I've ruined a lot of stencils by throwing them on the workbench when I was done using them.

Lastly, if you're doing t-shirts or patches using either method, you can make them last longer by heat setting the paint. Throw them in a hot drier for a few minutes or iron them with a piece of fabric between the shirt and the iron.

MAKING CD SLEEVES

Rachael started playing music again and wanted to share her music, so she recorded a CD. The CD was duplicated locally, but without inserts or jewel cases. It was expensive for those and she wanted something different.

She came home from the craft store with some black cardstock. The cardstock wasn't very stiff and she wasn't sure how she was going to actually make the case. The night before Mother's Day, I decided that I'd get something figured out for her.

I have a method I use for making CD cases out of paper, so I figured I'd polish it up a bit and do it with cardstock. I laid the CD on the cardstock and used a ruler to draw straight lines where I would normally fold the paper.

The only part that is really necessary is the cross shape in the middle. The corners are superfluous so they can come off. I wasn't really doing any measuring so to leave a margin for error, I didn't cut right on the lines.

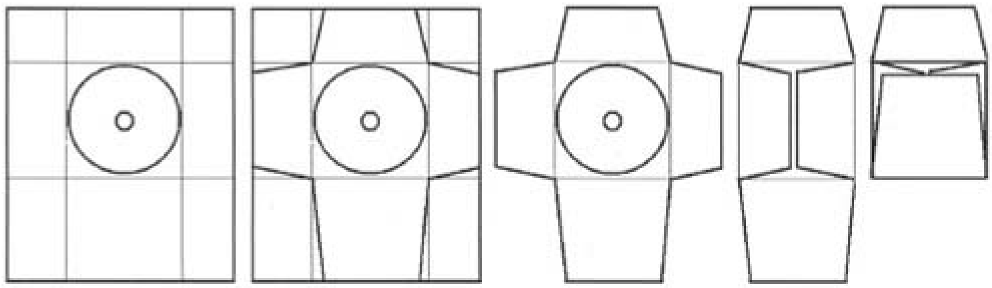
I started a little inside of the line and cut at an angle to the corner. This makes it so if you don't cut or fold just right, your edges still look good because they don't have to line up just right.

Fold on the lines to make sure a CD fits. If you're happy with it, you can use it to make a template. Then you can trace the shape onto cardstock and cut out a whole bunch at a time.

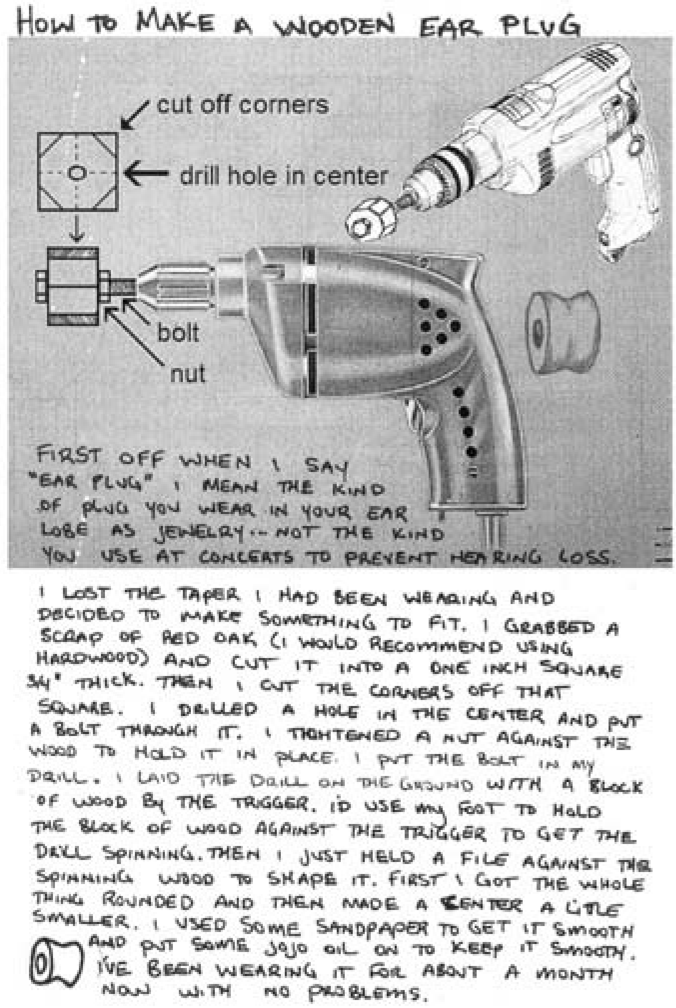
To finish them up fold in the side flaps, run a line of glue along the edge of each one, and fold the bottom flap up. To quote my ex-coworker, "Easy-peasy! They could train monkeys to do this!"

We stenciled ours after cutting but before folding. When they were all dry, one of us folded and the other glued. Put them under a book to hold them flat until the glue completely dry.

It's not fast but it can be nearly free!




Dry Bones Music



BICYCLE TUBE BUNGEE CORDS

Bike tubes often work better than store-bought bungee cords. They're easy enough to tie around something, so there's usually no need for hooks.

I'd been thinking about making some more standard type bungee cords and hadn't gotten around to it. Working on this book inspired me to do something about those ideas.

The part that held me back from creating bungee cords was the hooks. The hooks have to be strong enough so that they don't come unbent under load. Anything that will bend easily will also unbend easily. So you've got to put

some work into creating those hooks.

Use a standard wire clothes hanger. To make the hook strong enough, double it up. Take one side, straighten it out, and fold it in half. Stick it in a vise and twist about 10 times. This makes it a good deal stronger than a single wire.

Bend a small loop in one end using a needle nose pliers and a hook in the other end. Cut a length of tube about 16” long. Cut in half lengthwise and a slit about 1.5” long on each end.

Slip one side of the split end through the loop and tie the two ends together. Do this on both ends and you have a bungee cord!

Need something stronger? Use a thicker wire for the hook and don’t cut the tube in half lengthwise.

You can also reuse hooks from broken bungee cords, like the ones you find on the road biking around. Slip it through the bottom of the hook, cut a slit and tie a knot. Alternately, fold the end over and wrap a bit of wire around it. Both will work to keep the tube from slipping out of the hook.

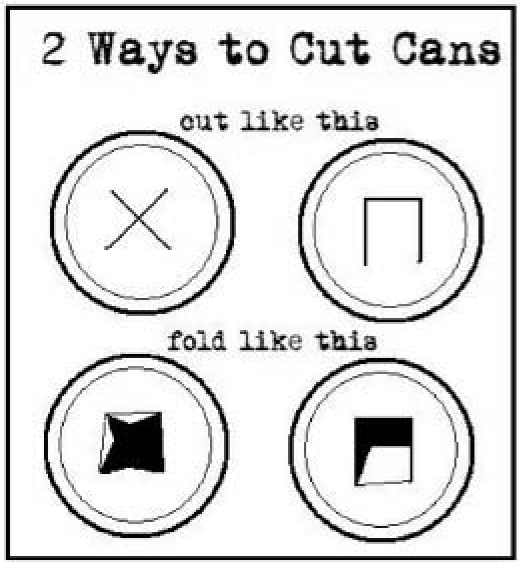
SODA CAN SOLAR PANEL

I've wanted to heat my garage in the winter. Electric heat won't work because there is minimal power: one 20 amp fuse for the whole garage. So the options are combustion (kerosene, propane, or wood) or solar.

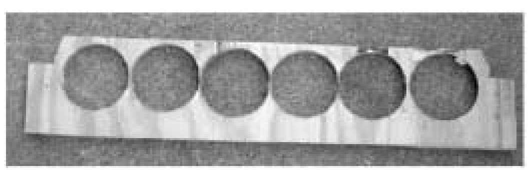
I wanted something really simple. My high school shop teacher had a solar collector made from aluminum soda cans, but its design seemed inefficient.

The idea is pretty simple. You paint aluminum cans black so they absorb the sun's heat. Aluminum conducts heat very quickly, so the air inside heats quickly. Hot air rises, so as the air heats it rises into the next can which is also hot and heats the air some more. As hot air rises, it pulls cool air from the bottom. At the top of the stacks, heated air moves into an "exhaust manifold" where it is forced through a vent.

I grabbed a few windows my neighbor was throwing out. There were a couple different sizes, so I measured some soda cans to see how many I could fit in each window. Cans are about 4.75" high and 2.5" wide. I went with the 50x17" window, which holds 54 cans. I also liked this one because it was rather tall. The taller the window, the more it allows air to be heated before reaching the top of the solar panel and releasing the air into the garage.




Gluing the Soda Cans



Start collecting and preparing soda cans. We are going to connect the cans in series so cut a hole in the bottom of each can. Cut three sides of a square and fold up the square up into the can. Point the flap towards the "front" of the can, so the air is directed to the hottest part of the can. I used the side you

would drink out of as the front.

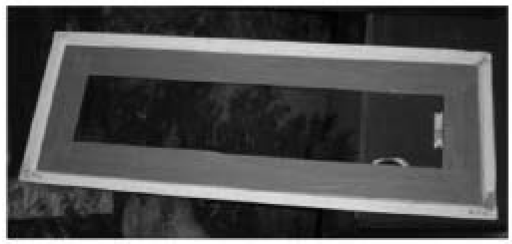
If you haven't rinsed out your cans yet, now would be a good time. After cutting holes in them, I put a bunch in my washer's draining tub. When the washer drained and filled up the sink, all the cans were washed and no water was wasted.

Use DAP All-Purpose Construction Adhesive or Liquid Nails to glue them together. You can use 2x2s or 2x4s as a "jig" to hold the cans while the glue dries. Set two 2x2's side by side so that the cans fit between them. Figure out how many cans you need in each row, and set out groups of prepared cans. I needed six stacks of nine cans, so I set out groups of nine cans.

Put a bead of the construction adhesive inside the rim of all the cans in a group except the top one, and put them between the 2x2s, making sure that the drinking hole is always on top. When they're all put together, put a hand on each end and push them all together to make sure they are good and tight.

Let them dry for a day and then paint them with flat black spraypaint. Lean the cans against a board and paint one side and then the other. You can probably get by with painting only the front side.

With the rows of soda cans prepared, it's time to get cracking on the solar panel body. Build a box to fit your window. If you build it out of 2x4s, it should be deep enough for the cans with a little bit of room for insulation. Screw the 2x4s together and screw a sheet of plywood to the 2x4" box. Make sure the window fits!



I wanted to separate the exhaust area from the rest of the panel. I wanted the air in the exhaust to come from the inside of the cans, and not flow up the front of the cans, perhaps bringing cooler air with it.

EXHAUST MANIFOLD

I made a panel that would block off the top of the box, except where the cans passed through it. Mine was made from a scrap of ½” thick plywood with 2.5” holes drilled for each row of cans. I centered my holes 2.5” apart, but that was a bit too tight. I would suggest giving yourself a little extra room.

Cover the back and sides of your box with insulation. I used ½” pink foam. This is like white Styrofoam but denser and with a plastic film on it. Its insulation value is R3, which is low. But you only need to prevent heat from escaping the box through the back and sides. When the window is attached to the box, it should rest against the foam. Use enough construction adhesive to hold the foam in place. On the back piece, you can probably press it into place. If you want, you can also caulk the seams.

Cut holes for the intake and exhaust. I went with one 1.75” hole centered at the top and bottom of the panel. I’ll probably go a little bigger once I figure out exactly how I fm going to mount it.

Now paint the whole thing black. Be careful: If you spraypaint the foam, the spraypaint will eat away the foam. The plastic film keeps that from happening because you're painting the plastic on top. If you have plastic that is peeling, cover it with duct tape.

Tape off the window and paint the frame and outside of the box black. You want everything to be black so the box absorbs as much heat as possible.

INTAKE MANIFOLD

You'll need something to keep the cans off the bottom of the box, so air can get into the holes in the bottom. I cut a large tin can lengthwise into thirds, and screwed the pieces together with the ends overlapping. This went under the row of cans, holding them up. The curve of the metal points the air to the bottom of the cans, and painted black it adds a little more heat.

Put a bead of construction adhesive around the inside of each hole in the exhaust manifold. Then put one stack of cans in place at a time, making sure the drinking hole is at the front of the divider. Put something heavy on top of the manifold to hold it all together while it dries.

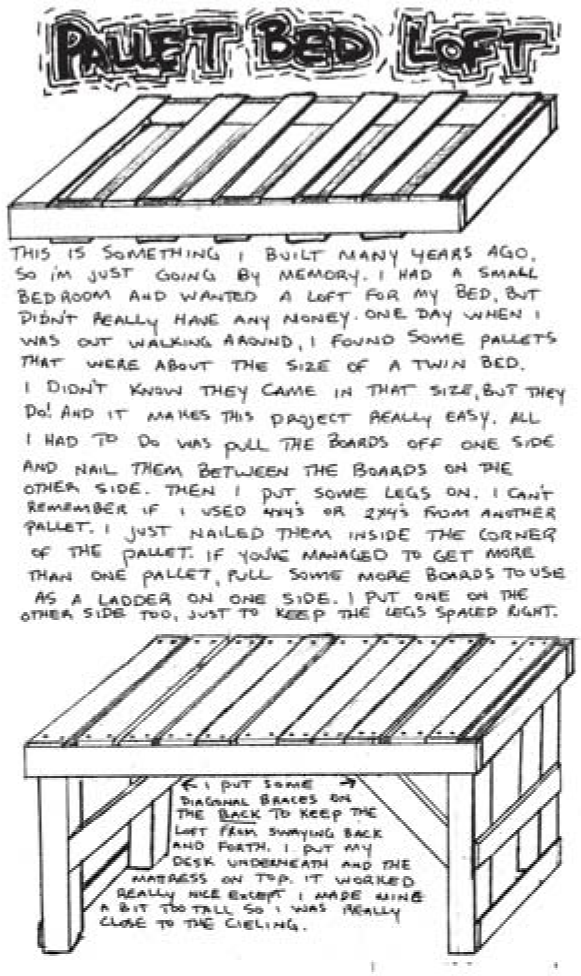
Cut a slot in the foam for the exhaust manifold and slip the cans in, resting them on top of the intake manifold. Attach your window and set it in the sun.

After it's been sitting in the sun for a while, put your hand in front of the exhaust hole. The air coming out should be quite warm! I used a thermometer to test mine. On a 35 degree day, the air coming out the exhaust hole reached 137 degrees Fahrenheit, heating the air over 100 degrees!

This type of solar collector is usually mounted on a south-facing wall, though they can be put on a roof as well. This small collector is large enough to hook up to a food dehydrator, but not large enough to make much difference in a cold garage.

You could build a bunch of these (or a very large one) and set them up with a thermostat and a fan. When the temperature reaches a certain point in the solar panels, the fan kicks on and starts blowing the hot air where it's needed. If it cools off too much, the fan shuts off until the solar panels heat up again.

The whole thing could be turned off with a switch. Or you could set up another thermostat indoors to turn off the fan before the collectors overheat your garage (or house).



DUMPSTER SHOPPING

I’m afraid to write about dumpster diving because I worry about changing the current system. Right now, it’s like a reverse of the class system. The underclass dig through the upper class’ garbage and, with a good amount of determination and luck, a person can find just about anything he or she needs.

So much is thrown away that an underclass person can bring more home than needed and then go sell some of it! That can be quite helpful to a lot of us.

I don’t need to depend on the dumpster for food, but it helps. I only take discarded items that I find useful. There are those who depend on what they find in the trash—the homeless, unemployed, or underemployed.

I hate to pass on information because I worry that the next step could be for people to dumpster only for fun—the stigma will be broken and it’ll be okay for the middle class to go rooting through the trash at Radio Shack for WebTV accessories.

I fear that they'll skip an important step—when we find trash and then go sell it to them! Maybe we don't make much money, but maybe the difference is enough to own our homes instead of renting. Maybe it's the seeds we plant in our garden or the extra room we build in our basement. Or maybe it buys us a part to fix the bike that we ride to work everyday.

But there are more problems. If more people are dumpstering and it becomes more popular, then the less popular it becomes for the people throwing away things. Store owners want you to buy stuff from them. They don't realize that people in the trash are probably not going to go in the front door—those people either don't have the money or are concerned with reducing waste.

I also worry that people who don't dumpster for a living won't have the best dumpster etiquette. They'll be out there in the middle of the day in full view of employees or customers. They'll leave a mess and ruin it for the rest of us. Stores will know that people are taking their garbage and may take steps to prevent it. Even stores that don't care will still be annoyed by a mess.

Or, worst of all—fruit and vegetables will rot in the refrigerators of people who won't even bother to compost!

You're not born with dumpster etiquette but you do learn that other people rely on the same trash. If you take all of the bread in the dumpster, the next person won't find any (or vice versa). If you leave a mess and the dumpster becomes locked as a consequence, you and everyone else will be out of luck!

I don't mind sharing. There's plenty of waste for a lot of people. But I don't want to lose that privilege because some weekend warriors went out for an adventure. They won't notice when dumpsters are replaced by compactors. They'll find something else to do.

Almost every dumpster I frequent has been brought to my attention by word of mouth. Someone happens upon a teeming dumpster of goodies and passes

word to a friend who passes word to another. Good dumpsters go to waist, not to waste! We only pass the word along to people for whom it may prove useful. If it seems like a dumpster will only serve a few people's needs, we'll be more selective about who we tell. When goodies start to wane, fewer people will come, although those that do may find more.

This isn't not a written rule, but it's subconscious and it seems to work.

MATERIALS & TECHNIQUES

Go out and pick up a mini Maglite (the size that uses two AA batterys) that comes with a belt holster. Wrap a few layers of duct tape around the handle and stow it on your belt. A knife is a good tool, too. I like to use boot knives and throwing knives. They're small and thin, usually with a holster for your belt. Generally, you don't have to open them, so they require only one hand to use.

Next, get a decent-sized canvas bag. This isn't necessary but it's pretty handy. It's a good place to keep spare plastic bags.

Think about what you can use. We can all use food—some places that throw it away are restaurants, grocery stores, and gas stations. But also look up food distributors in the phone book. Try to find some that toss organic food.

If you need electronics, look behind the appropriate stores. If you want bagels, look behind the bagel shop. If you want movies, try the rental shops. For bike stuff, check the bike shops. Old tubes are a dime a dozen and are easily patched if they have a hole.

Watch for "Going out of Business" signs and read them as "Check the Dumpster!" You wouldn't believe what businesses will toss. In America, people throw away everything.

Start checking dumpsters until you find the good ones that fit your needs, and then you can build a routine.

I go out at night and try to hit as many places as I can. Night is preferable because the businesses are closed and you can work under the cover of darkness—which is also why you should have a flashlight. Grab your bag, look for employees or cops, and approach the dumpster. Take a look and make sure there isn't a big pile of fish guts or something that you'll step into. Jump in and hold your flashlight in your teeth. The duct tape will make this much more comfortable and prevent the Maglite from falling out of its holster when not in use.

Move objects around and cycle them from the bottom to the top. Open up bags and see if there's anything you are looking for. Don't make a mess outside of the dumpster and always leave the area cleaner than you found it. Unless you are in no danger of being discovered, don't stick around too long inspecting every nook and cranny.

Put everything in your bag and be on your way. If you're discovered, there's a better chance that the dumpster will not be available in the future. And if you are caught, talking to yourself and acting crazy has proven to be a good way to stay out of trouble without explaining to the cops that you are some kind of crazed radical.

When dumpstering unwrapped produce, it's always a good idea to use plastic bags and then to wash everything before eating. I normally wash it all at once, dry it, and refrigerate. If you're dumpstering packaged food, check the expiration dates, but keep in mind that food does not go bad once the clock hits midnight on the given day. This date is arbitrary and is set up to ensure that food isn't on the shelf when it does go bad. It may explore shortly after or quite some time after that, but it probably doesn't expire on the expiration date.

For fresh stuff, like sandwiches, I give them an extra day or two. For chips or dry goods, they are usually good until they go stale. Bread is good until it molds. Veggies are good until they rot. Donuts and bagels will become too hard. Most things can be stored indefinitely in a freezer. If it tastes and smells okay, it's probably okay to eat.

PARTING WORDS

Eating trash may not work for you right away. Our upbringing often makes it feel repulsive to eat something that we know came from a dumpster. The first time you eat donuts or veggies out of the garbage, it may feel a bit weird.

More often than not, this isn't because the food is bad, but because you have a natural apprehension about eating garbage, and it manifests itself in symptoms similar to if you had eaten bad food.

It's like hypochondria: if you think you're sick, you'll feel sick. After eating lots of good food from the garbage, that mental block will go away.

But even now, when someone says something about what I'm eating, it will have that effect. I've told Rachel that even if food isn't spoiled, she can spoil it by saying something nasty about it!

The best advice I can give is: make a conscious decision to change your mindset about dumpsters. Start thinking about them as your personal free store. Assume that, until you check and are proven wrong, whatever you need

has been thrown away there. When other people are heading in the front door, check around back. Keep your eyes open and be vigilant.